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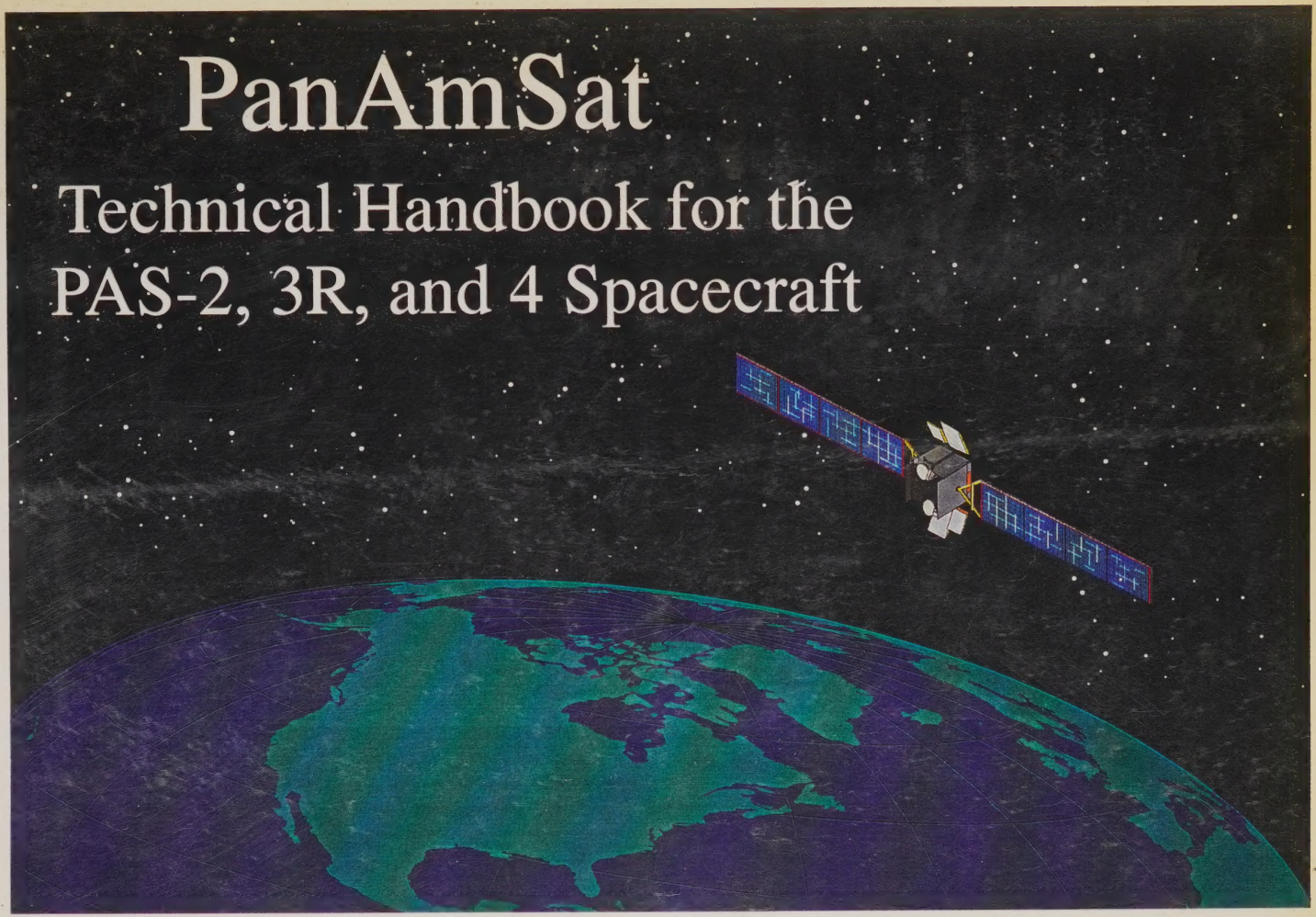
Technical Handbook for the PAS-2, 3R, and 4 Spacecraft



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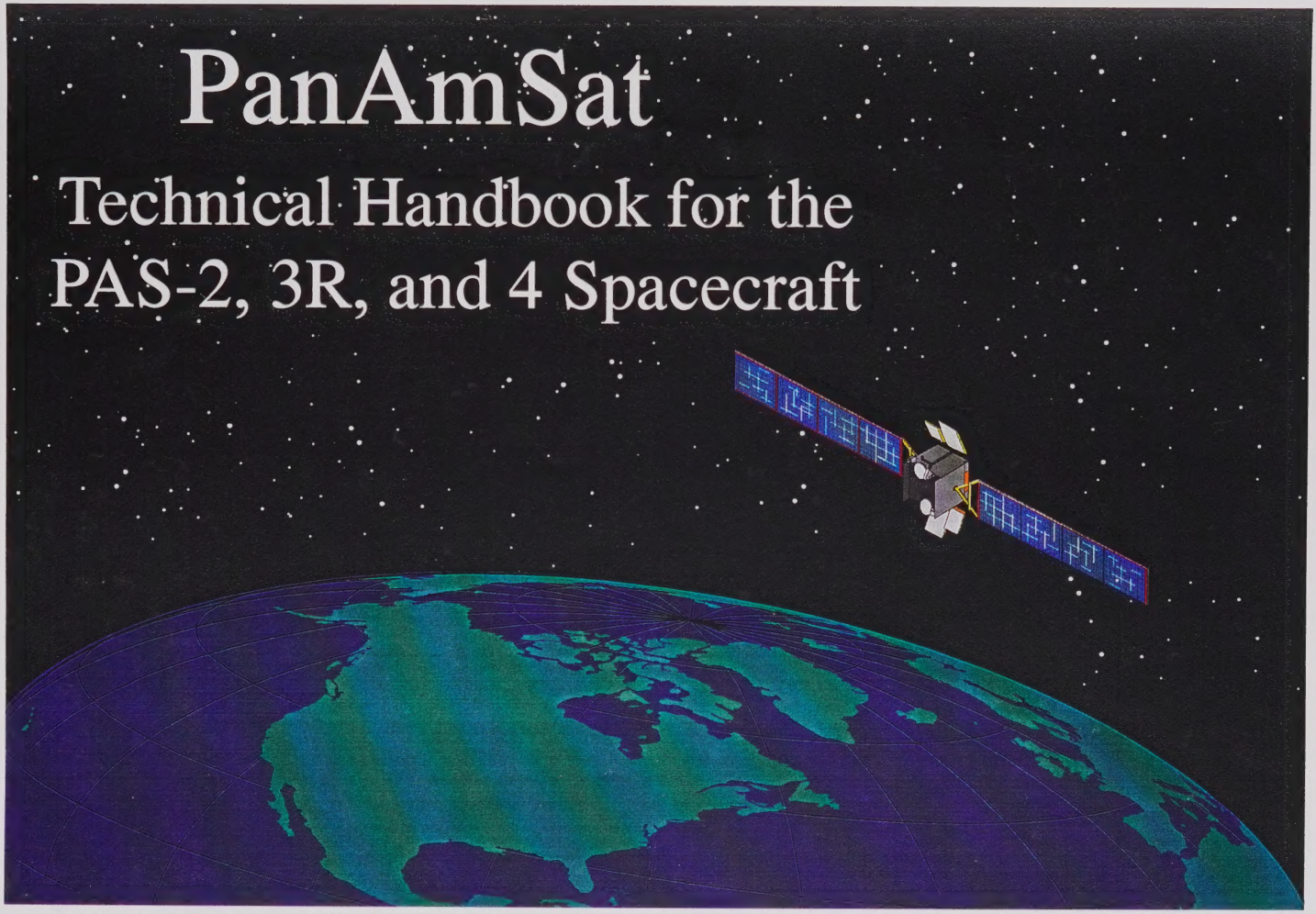

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Technical Handbook

for the

PAS-2, 3R, and 4 Spacecraft

January 1997

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General Information

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General Satellite Information

Orbital Locations: PAS-2 191 degrees W.L. (POR Primary)
PAS-3R 43 degrees W.L. (AOR Follow-On)
PAS-4 68.5 degrees E.L. (IOR Primary)

Orbital Control: +/- 0.05 degrees Inclination and Longitude

Spacecraft Type: Hughes 601 series, 3-axis stabilized

Design Lifetime: 15 years

PAS-2 and 3R Payload: 12 X 54 / 4 X 64 MHz C-Band 34 Watt SSPAs
12 X 54 / 4 X 64 MHz Ku-Band 63 Watt TWTAs

PAS-4 Payload: 12 X 54 / 4 X 64 MHz C-Band 30 Watt SSPAs
16 X 27 MHz Ku-Band 60 Watt TWTAs
6 X 54 / 2 X 64 MHz Ku-Band 60 Watt TWTAs

Frequency Bands:

C-Band	Uplink	5.925 - 6.425 GHz
	Downlink	3.700 - 4.200 GHz
PAS-2 Ku-Band	Uplink	14.000 - 14.500 GHz
	Downlink	12.250 - 12.750 GHz
PAS-3R Ku-Band	Uplink	14.000 - 14.500 GHz
	Downlink	11.700 - 12.200 GHz and 12.500 - 12.750 GHz
PAS-4 Ku-Band	Uplink	14.000 - 14.500 GHz
	Downlink	11.450 - 11.700 GHz and 12.250 - 12.750 GHz

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C-Band Payload Information

Number of Transponders:	16 with 4 spares
Transponder Bandwidth:	12 - 54 MHz 4 - 64 MHz 6 MHz Guard Bands
Polarization:	Linear - Horizontal and Vertical
SFD (0.0 G/T and 0 dB attn):	-98.8 dBW/m^2 (PAS-2) -96.0 dBW/m^2 (PAS-3R/4)
Input Attenuators:	0 to 15 dB in 1 dB steps Nominal 7 dB Setting
G/T:	2.0 to -12.0 dB/K
EIRP:	27 to 41 dBW
Beacons:	Horizontally Polarized, 0 dBW PAS-2: 4.1985 and 4.1995 GHz PAS-3R: 4.1985 and 4.1990 GHz PAS-4: 4.1990 and 4.1995 GHz

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Ku-Band Payload Information - PAS-2/3R

Number of Transponders:	16 with 4 spares
Transponder Bandwidth:	12 - 54 MHz 4 - 64 MHz 6 MHz Guard Band
Polarization:	Linear - Horizontal and Vertical
SFD (0.0 G/T and 0 dB attn):	-90.4 dBW/m^2 (PAS-2) -89.0 dBW/m^2 (PAS-3R)
Input Attenuators:	0 to 15 dB in 1 dB steps Nominal 11 dB Setting
G/T:	+3 to -7.0 dB/K
EIRP:	40 to 54 dBW
Uplink Power Control (UPC) Beacon Frequency:	12.50 GHz (5 dBW) RHCP and LHCP (PAS-2) 11.699 GHz (5 dBW) RHCP and LHCP (PAS-3R)

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Ku-Band Payload Information - PAS-4

Number of Transponders:	24 with 6 spares
Transponder Bandwidth:	16 - 27 MHz 6 - 54 MHz 2 - 64 MHz
Polarization:	Linear - Horizontal and Vertical
SFD (0.0 G/T and 0dB attn) :	-86.0 dBW/m^2 (54/64 MHz Transponders) -89.0 dBW/m^2 (27 MHz Transponders)
Input Attenuators:	0 to 15 dB in 1 dB steps Nominal 9 dB Setting (54/54 MHz Transponder) Nominal 6 dB Setting (27 MHz Transponder)
G/T:	+3 to -7.0 dB/K
EIRP:	40 to 55 dBW
Uplink Power Control (UPC) Beacon Frequency:	12.50 GHz (5 dBW) RHCP and LHCP

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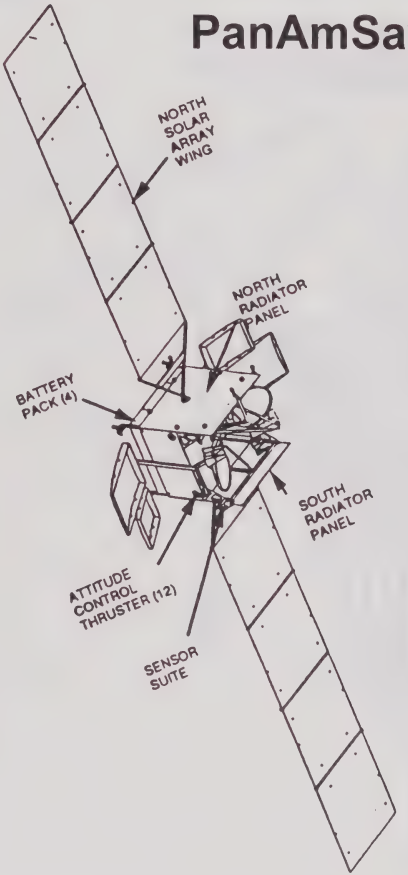
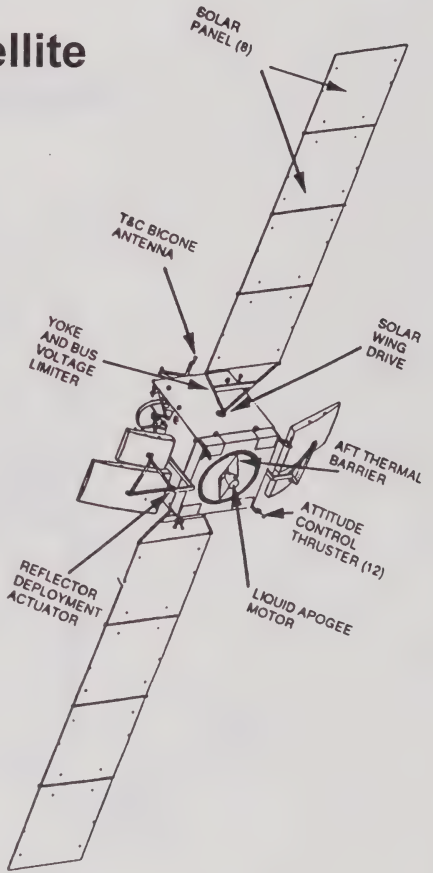
PanAmSat HS-601 Satellite





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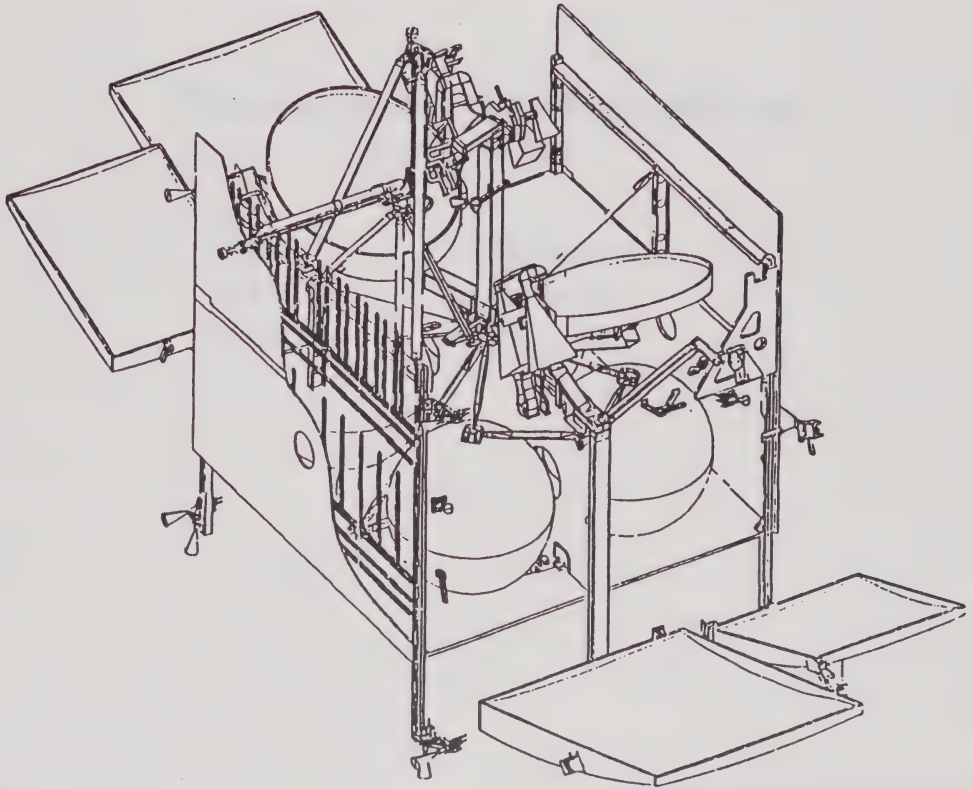
PanAmSat Satellite Cutaway



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Transponder Configurations

September 1996

PAS-2	**In Service**
PAS-3R	**In Service**
PAS-4	**In Service**

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Standard Transponder Operating Characteristics (C-Band and Ku-Band)

		C-Band	Ku-Band
Input/Output Backoff:	Single Carrier -	0 dB / 0 dB	0 dB / 0 dB
	Two Carrier -	0 dB / 1.6 dB	0 dB / 1.2 dB
	Multi-Carrier -	3.8 dB / 3.5 dB	8.2 dB / 3.5 dB
Minimum C/Im :	16 to 18 dB		
Maximum Receiver Phase Shift:	2 degrees		
Bandwidth :	54/64 Mhz		

In-Band Frequency Response: (Peak to Peak Variation)	C-Band 54 MHz Channel	C-Band 64 MHz Channel
	1.2 dB (+/- 24 MHz)	1.3 dB (+/- 29 MHz)
	2.0 dB (+/- 27 MHz)	2.3 dB (+/- 32 MHz)

Ku-Band 27 MHz Channel	Ku-Band 54 MHz Channel	Ku-Band 64 MHz Channel
1.4 dB (+/- 10.7 MHz)	1.2 dB (+/- 21.6 MHz)	1.2 dB (+/- 25.6 MHz)
2.0 dB (+/- 12.15 MHz)	1.5 dB (+/- 24.3 MHz)	1.5 dB (+/- 28.8 MHz)
3.0 dB (+/- 13.5 MHz)	2.8 dB (+/- 27.0 MHz)	3.5 dB (+/- 32.0 MHz)

Notes: 1) C/Im specification assumes listed backoff criteria.
2) Frequency response is for carrier levels between saturation and 10 dB below saturation at C-band, and between saturation and 20 dB below at Ku-band.

Standard Transponder Operating Characteristics (Continued)

Amplitude Linearity (C/3IM):

Total Output Backoff Relative to Single Carrier Saturation, dB	C/3IM
-2	16
-3	20
-4	24
-6	25.5
-8	30

Nominal Input Attenuator Setting:	C-Band	Ku-Band
Single/Dual Mode:	7 dB	6 dB to 11 dB
Multi-Carrier:	7 dB	11 dB

Notes: 3) Amplitude linearity parameters are the same for C-band and Ku-band transponders.
4) Group delay envelope available on request.

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Nominal Gain Transfer Characteristics
Linearized SSPAs (C-Band)

	NOMINAL OUTPUT BACKOFF (dB)		
INPUT BACKOFF(dB)	Single Carrier	Dual Carrier	Multi-Carrier
0.0	0.0	1.6	2.2
1.0	0.6	1.8	2.3
2.0	1.1	2.0	2.6
3.0	1.9	2.5	3.0
4.0	2.8	3.1	3.6
5.0	3.7	3.9	4.2
6.0	4.6	4.7	5.0
7.0	5.5	5.6	5.8
8.0	6.5	6.6	6.6
9.0	7.4	7.5	7.6
10.0	8.4	8.4	8.5
11.0	9.3	9.4	9.4
12.0	10.3	10.3	10.4

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Nominal Gain Transfer Characteristics
Linearized TWTAs (Ku-Band)

	NOMINAL OUTPUT BACKOFF (dB)		
INPUT BACKOFF(dB)	Single Carrier	Dual Carrier	Multi-Carrier
0.0	0.0	1.2	1.5
1.0	0.0	1.3	1.5
2.0	0.0	1.3	1.5
3.0	0.1	1.4	1.7
4.0	0.3	1.6	1.9
5.0	0.6	1.8	2.2
6.0	1.0	2.1	2.5
7.0	1.6	2.5	2.9
8.0	2.3	3.0	3.4
9.0	3.2	3.6	4.0
10.0	4.1	4.4	4.7
11.0	5.1	5.2	5.5
12.0	6.1	6.2	6.3

PAS-2 (POR) Frequency Plan Interconnection Matrix, and Contour Maps

Notes: 1) EIRP & G/T values are minimum expected end-of-life.
2) PAS recommends that 0.5dB additional margin be applied to values shown.
3) Zero and five degree elevation look angles are shown where applicable.

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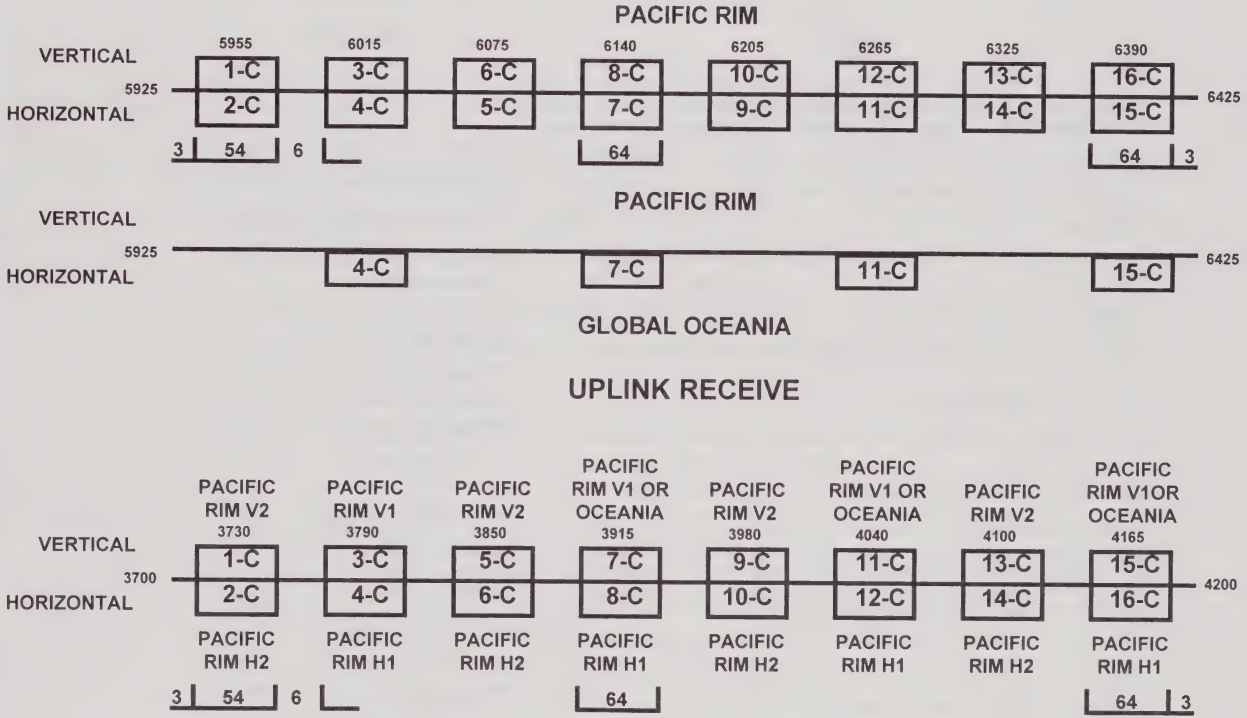
PAS-2 (POR) C-Band Frequency Plan



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PAS-2 (POR) C-Band Interconnection Matrix

Downlink			Uplink				
Channel	Pol	Coverage	C-Band Vert Pacific Rim	C-Band Horiz Pacific Rim	C-Band Horiz Oceania	Ku-Band Vert Asia	Ku-Band Horiz Asia/Australia
1-C	V	Pacific Rim Beam V2	1-C				10-K
3-C	V	Pacific Rim Beam V1	3-C			12-K	
5-C	V	Pacific Rim Beam V2		5-C		13-K	
7-C	V	Pacific Rim Beam V1 or Oceania		7-C	7-C		15-K
9-C	V	Pacific Rim Beam V2		9-C			
11-C	V	Pacific Rim Beam V1 or Oceania		11-C	11-C		
13-C	V	Pacific Rim Beam V2	13-C				
15-C	V	Pacific Rim Beam V1 or Oceania		15-C	15-C		
2-C	H	Pacific Rim Beam H2		2-C		9-K	
4-C	H	Pacific Rim Beam H1		4-C	4-C		11-K
6-C	H	Pacific Rim Beam H2	6-C				14-K
8-C	H	Pacific Rim Beam H1	8-C			16-K	
10-C	H	Pacific Rim Beam H2	10-C				
12-C	H	Pacific Rim Beam H1	12-C				
14-C	H	Pacific Rim Beam H2		14-C			
16-C	H	Pacific Rim Beam H1	16-C				

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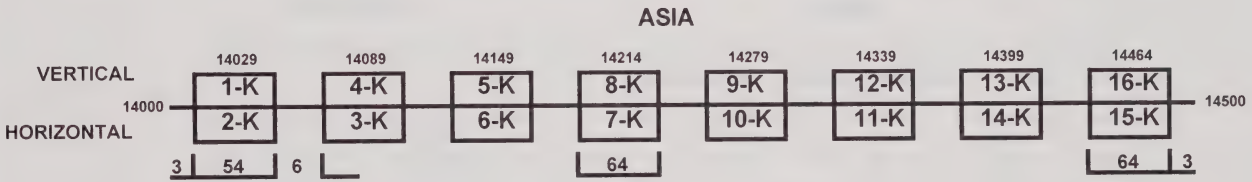
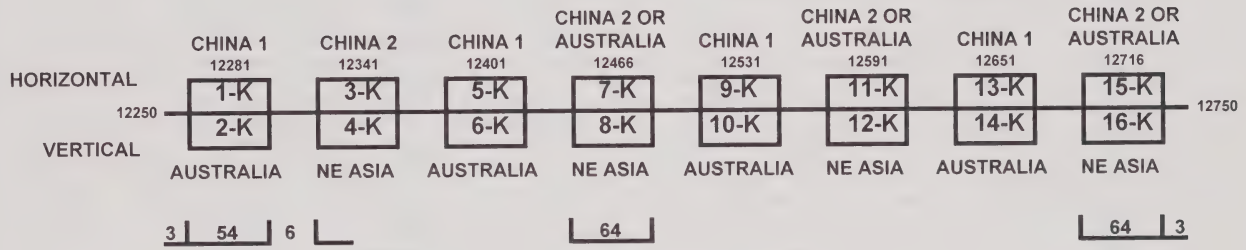
PAS-2 (POR) Ku-Band Frequency Plan



ASIA/AUSTRALIA

UPLINK RECEIVE



DOWNLINK TRANSMIT

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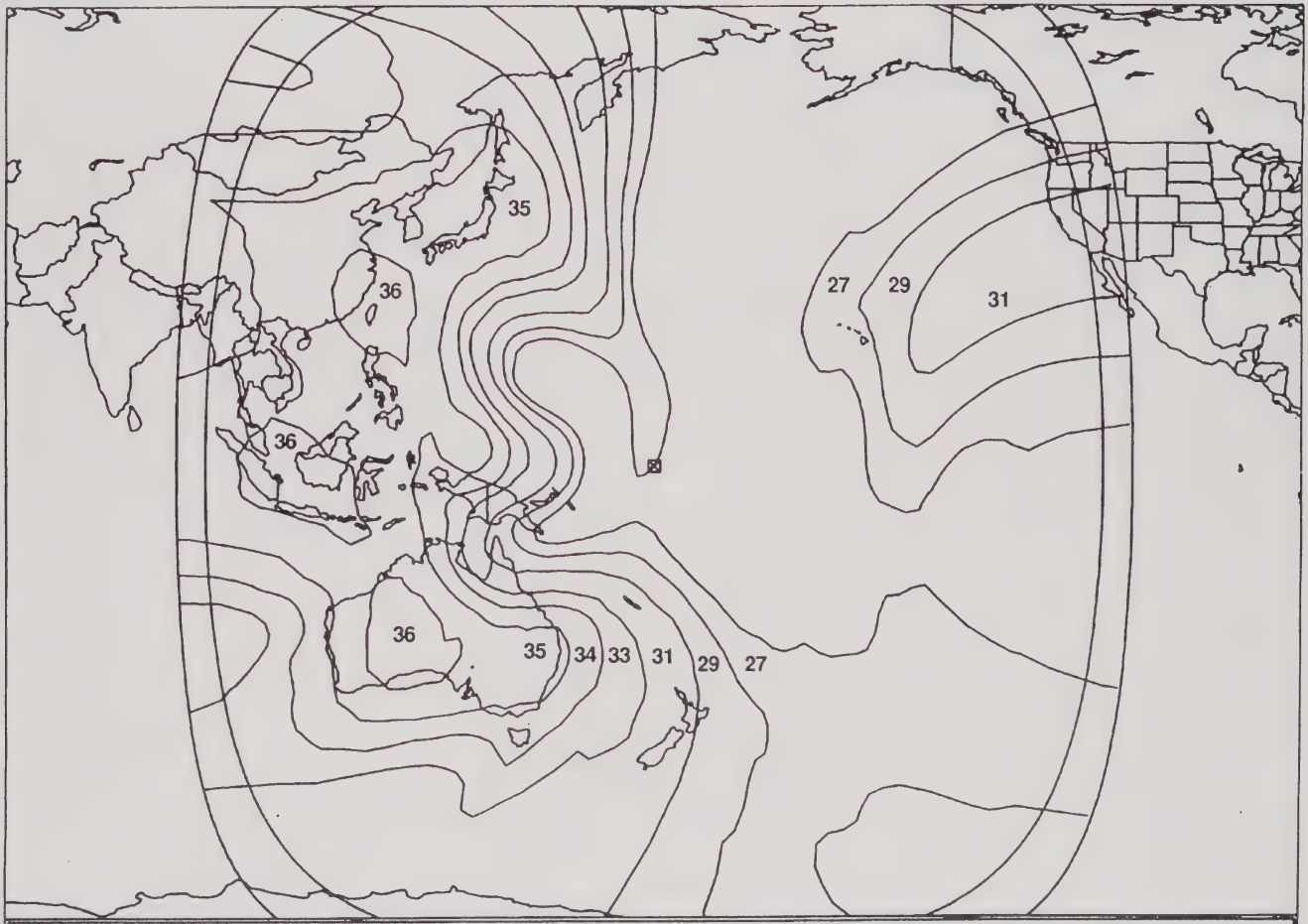
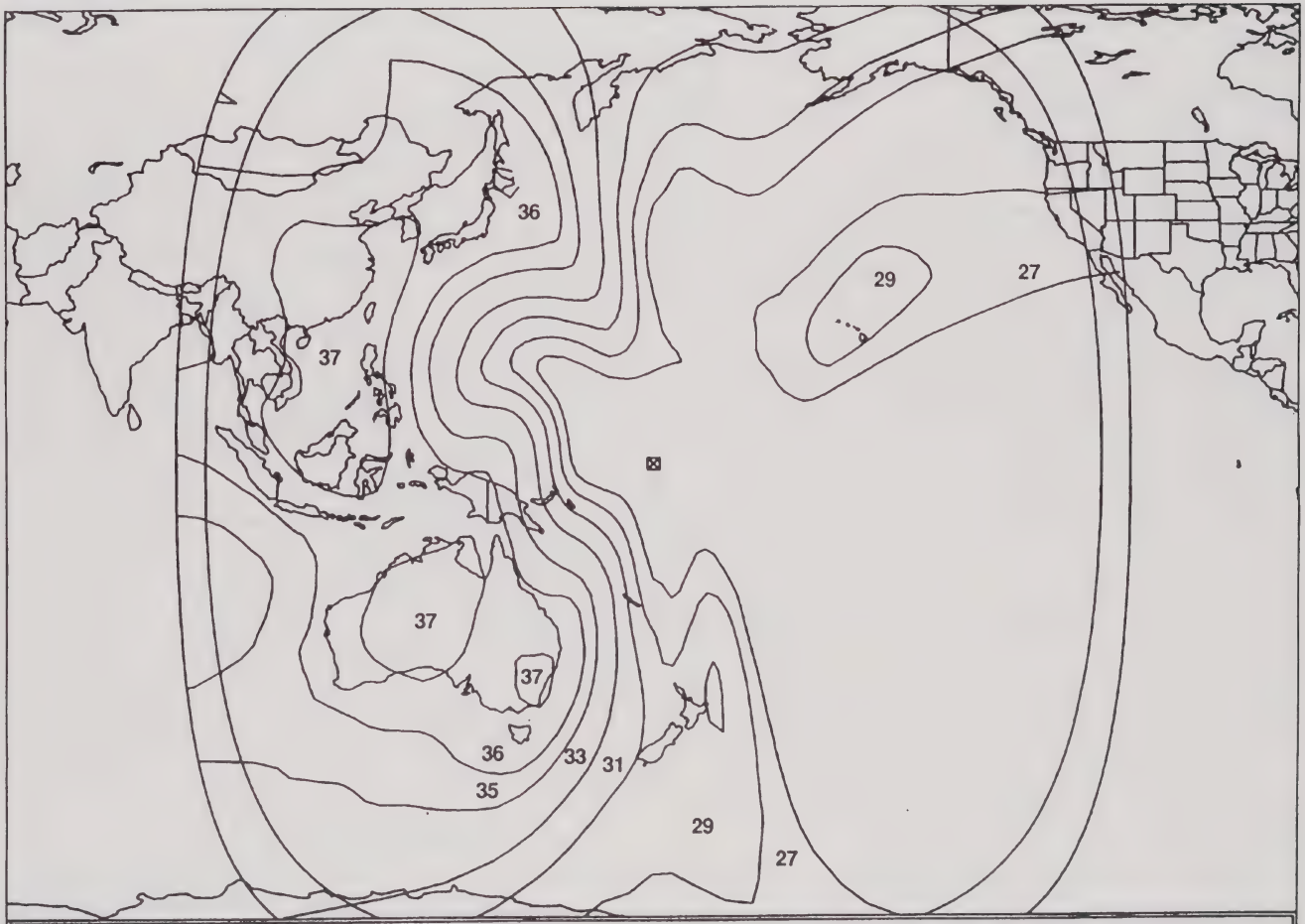
PAS-2 (POR) Ku-Band Interconnection Matrix

Downlink			Uplink				
Channel	Pol	Coverage	Ku-Band Vert Asia	Ku-Band Horiz Asia/Australia	C-Band Vert Pacific Rim	C-Band Horiz Pacific Rim	C-Band Horiz Oceania
1-Ku	H	China Beam 1	1-K				
3-Ku	H	China Beam 2		3-K			
5-Ku	H	China Beam 1	5-K				
7-Ku	H	China 2 or Australia		7-K			
9-Ku	H	China Beam 1	9-K			2-C	
11-Ku	H	China 2 or Australia		11-K		4-C	
13-Ku	H	China Beam 1	13-K			5-C	
15-Ku	H	China 2 or Australia		15-K		7-C	
2-Ku	V	Australia		2-K			
4-Ku	V	Northeast Asia	4-K				
6-Ku	V	Australia		6-K			
8-Ku	V	Northeast Asia	8-K				
10-Ku	V	Australia		10-K	1-C		
12-Ku	V	Northeast Asia	12-K		3-C		
14-Ku	V	Australia		14-K	6-C		
16-Ku	V	Northeast Asia	16-K		8-C		



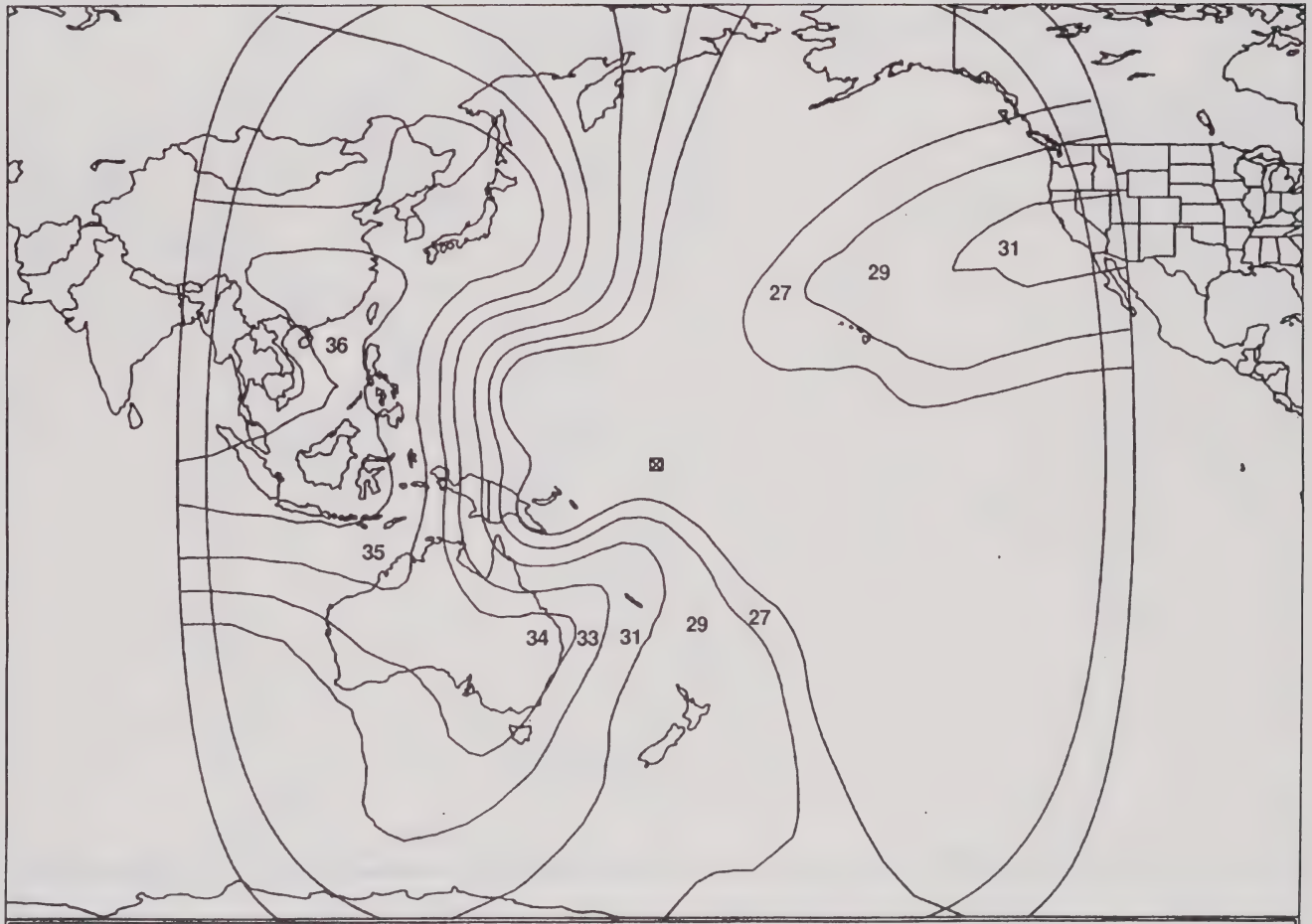
PAS-2 Pacific Rim Horizontal Beam 1 C-Band

(CONTOURS: 36, 35, 34, 33, 31, 29, 27 dBW)



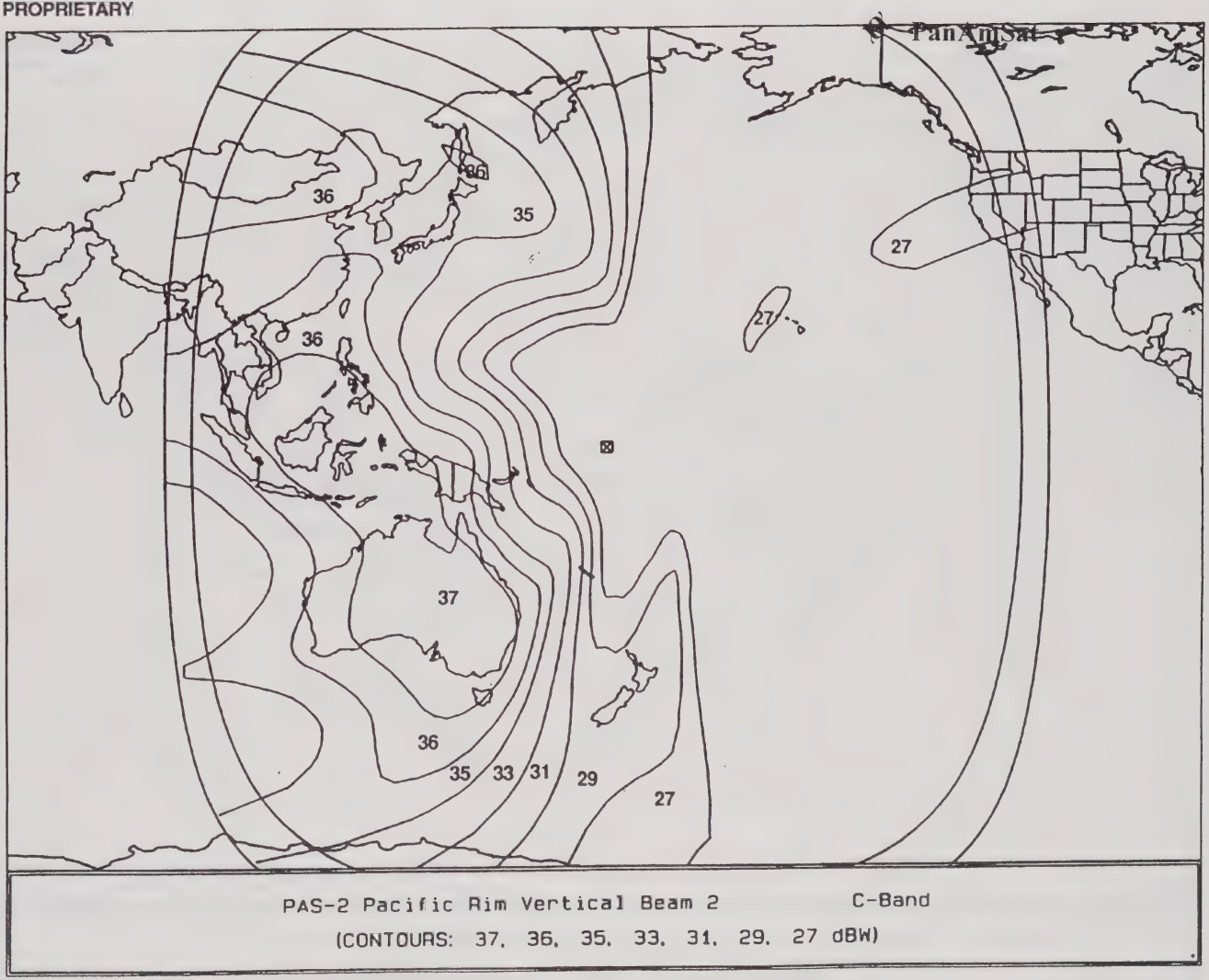
PAS-2 Pacific Rim Horizontal Beam 2 C-Band

(CONTOURS: 37, 36, 35, 33, 31, 29, 27 dBW)



PAS-2 Pacific Rim Vertical Beam 1 C-Band

(CONTOURS: 36, 35, 34, 33, 31, 29, 27 dBW)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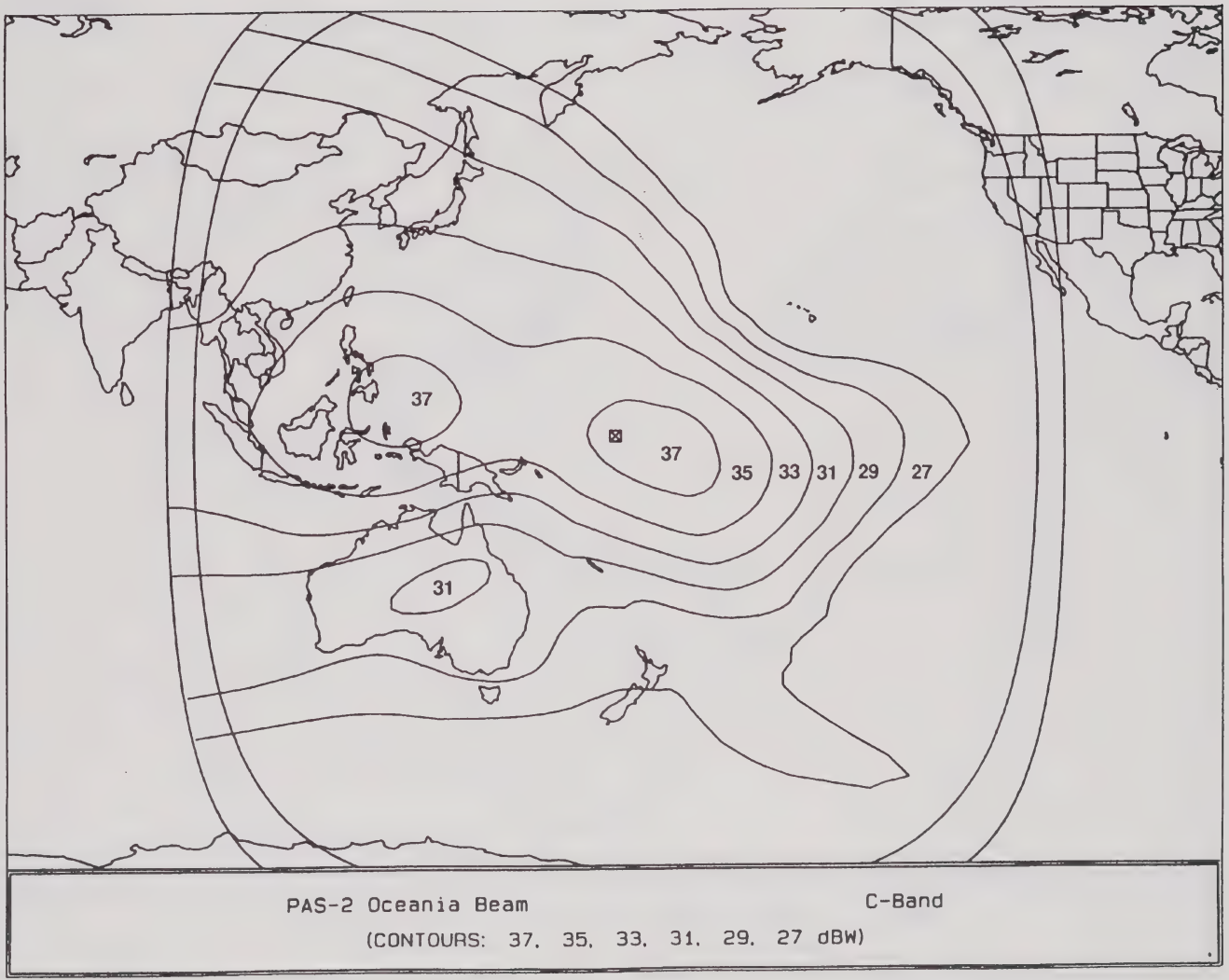
PAS-2 Pacific Rim Vertical Beam 2
C-Band
(CONTOURS: 37, 36, 35, 33, 31, 29, 27 dBW)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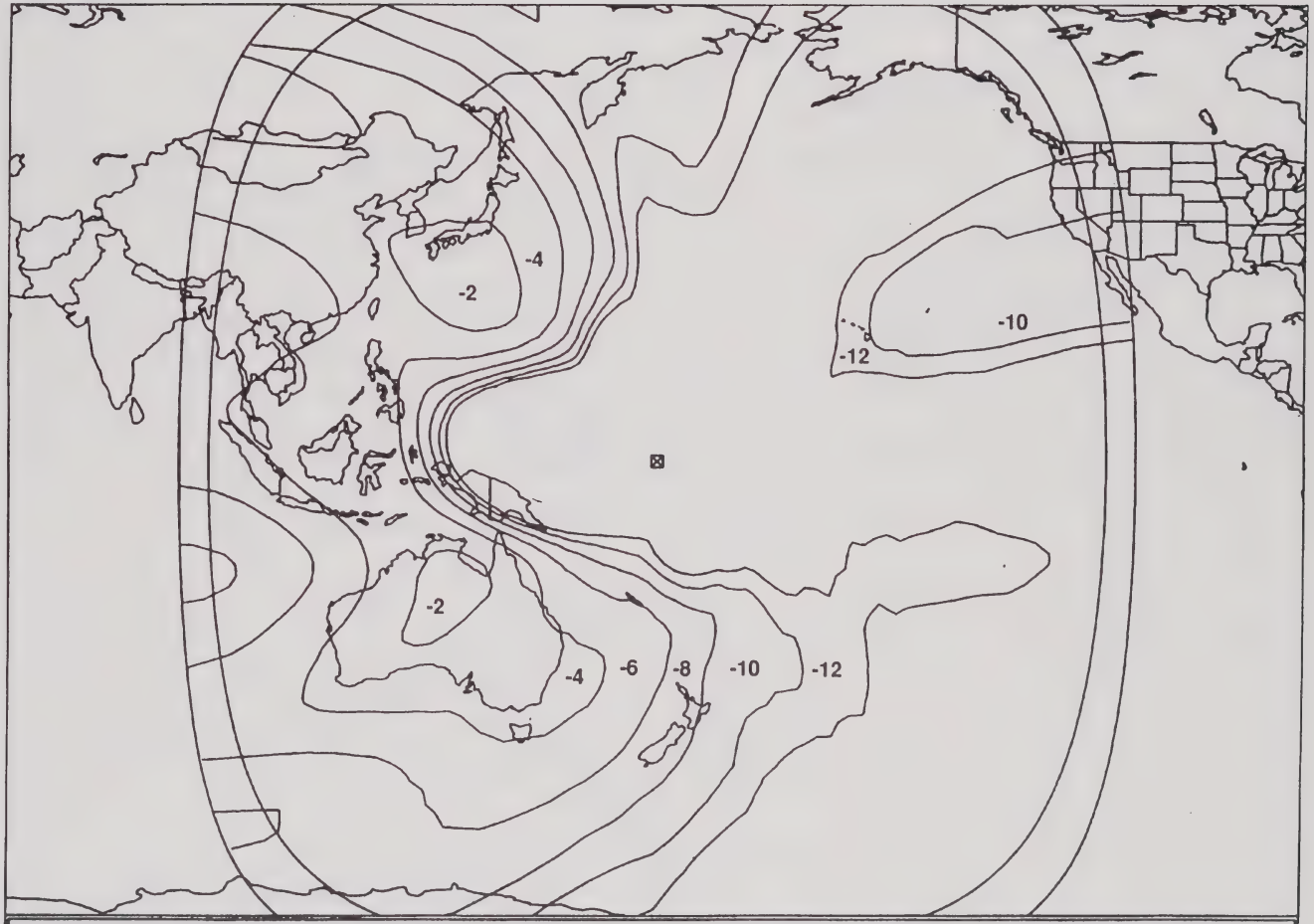
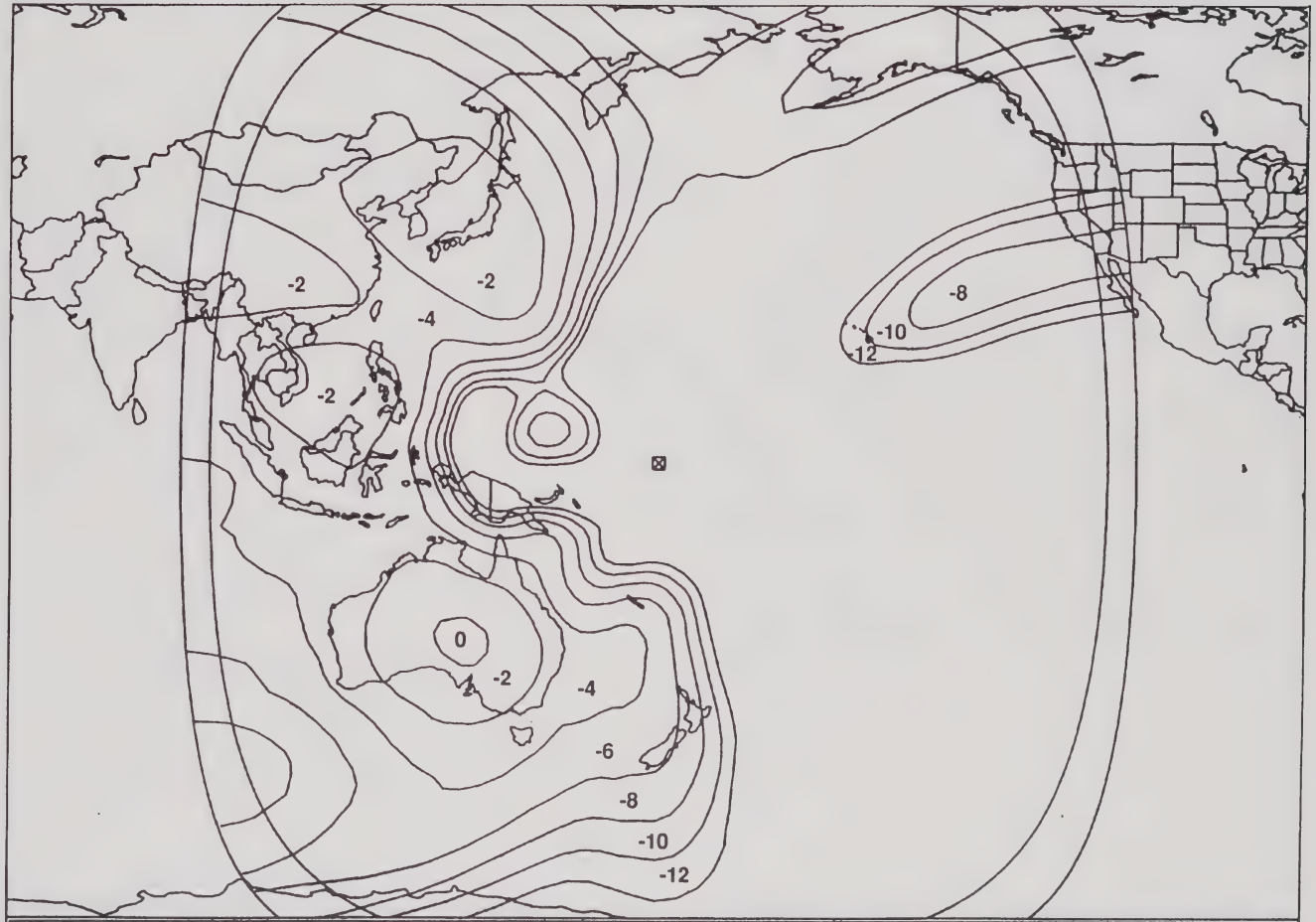
PAS-2 Oceania Beam
C-Band
(CONTOURS: 37, 35, 33, 31, 29, 27 dBW)

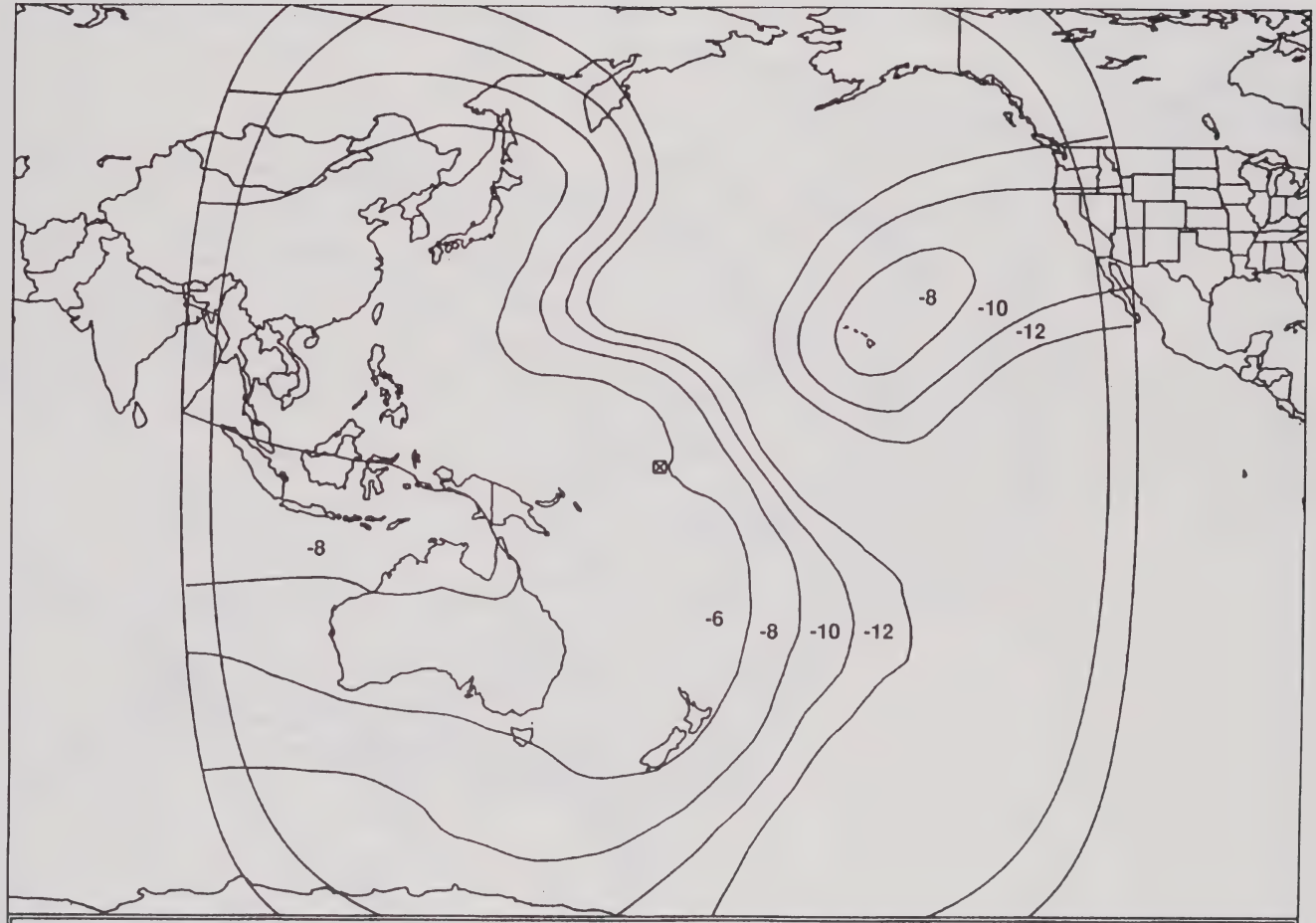


PAS-2 Pacific Rim Horizontal Uplink Beam C-Band
(CONTOURS: -2, -4, -6, -8, -10, -12 dB/K)



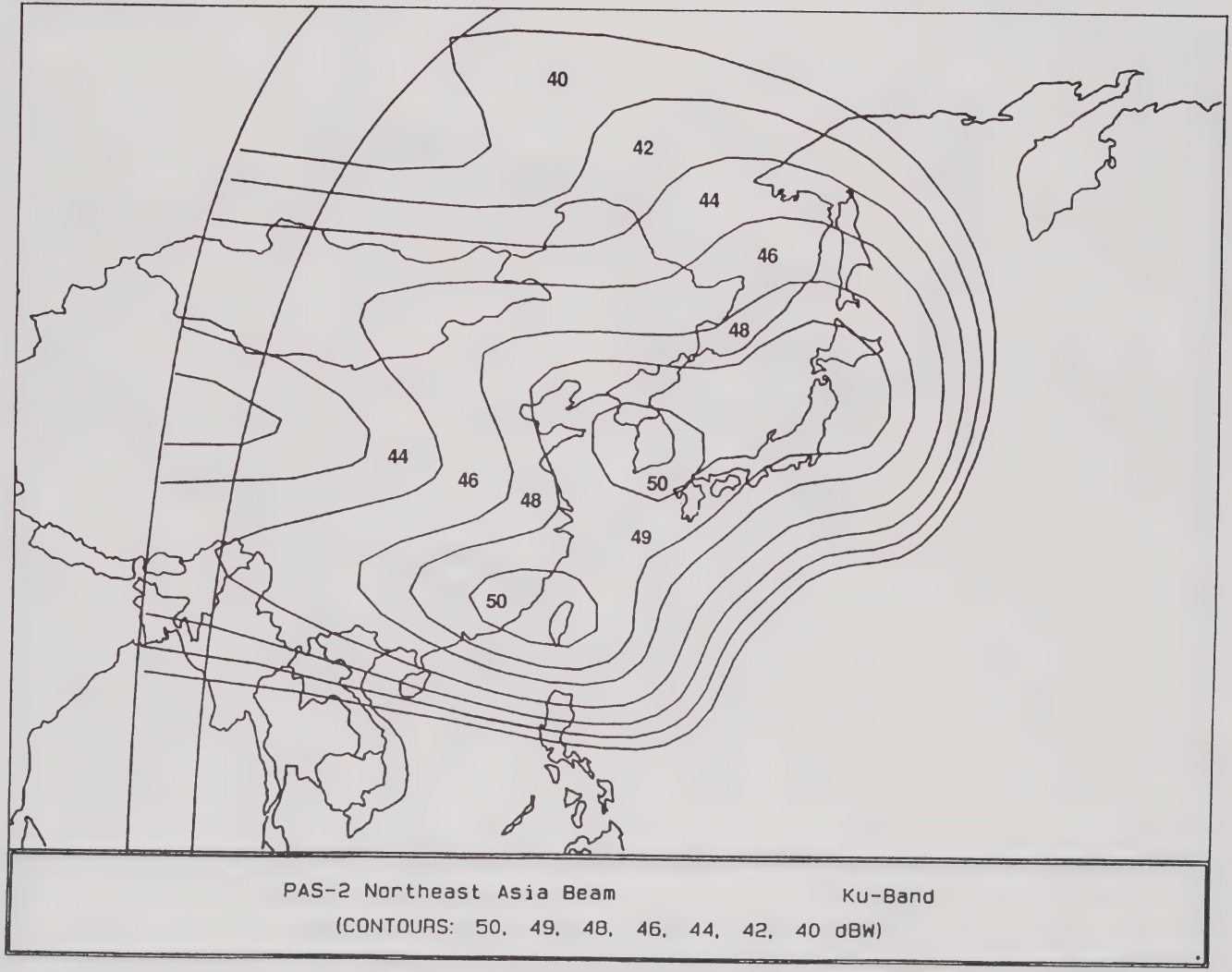
PAS-2 Pacific Rim Vertical Uplink Beam C-Band

(CONTOURS: 0, -2, -4, -6, -8, -10, -12 dB/K)



PAS-2 Oceania Uplink Beam C-Band

(CONTOURS: -6, -8, -10, -12 dB/K)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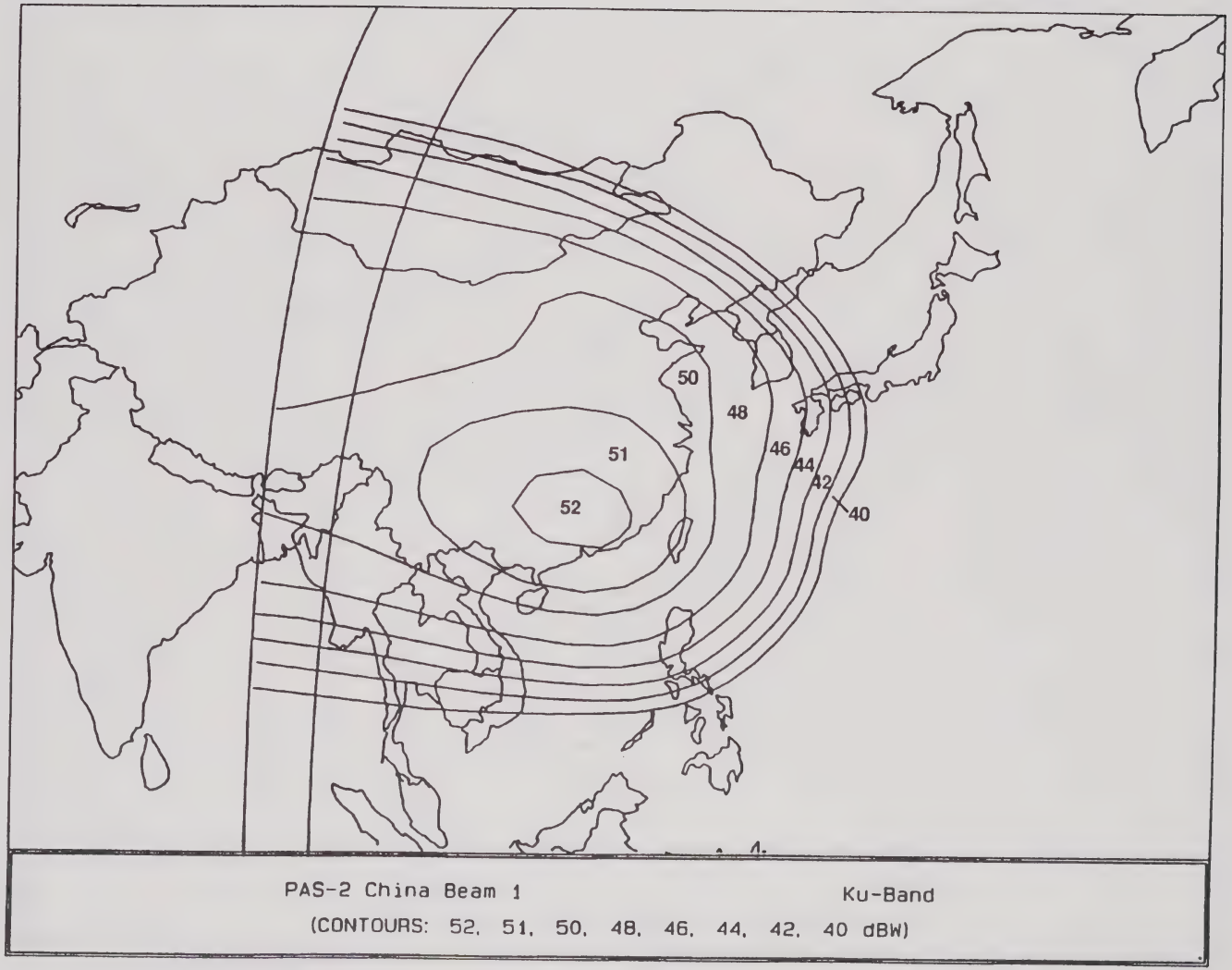
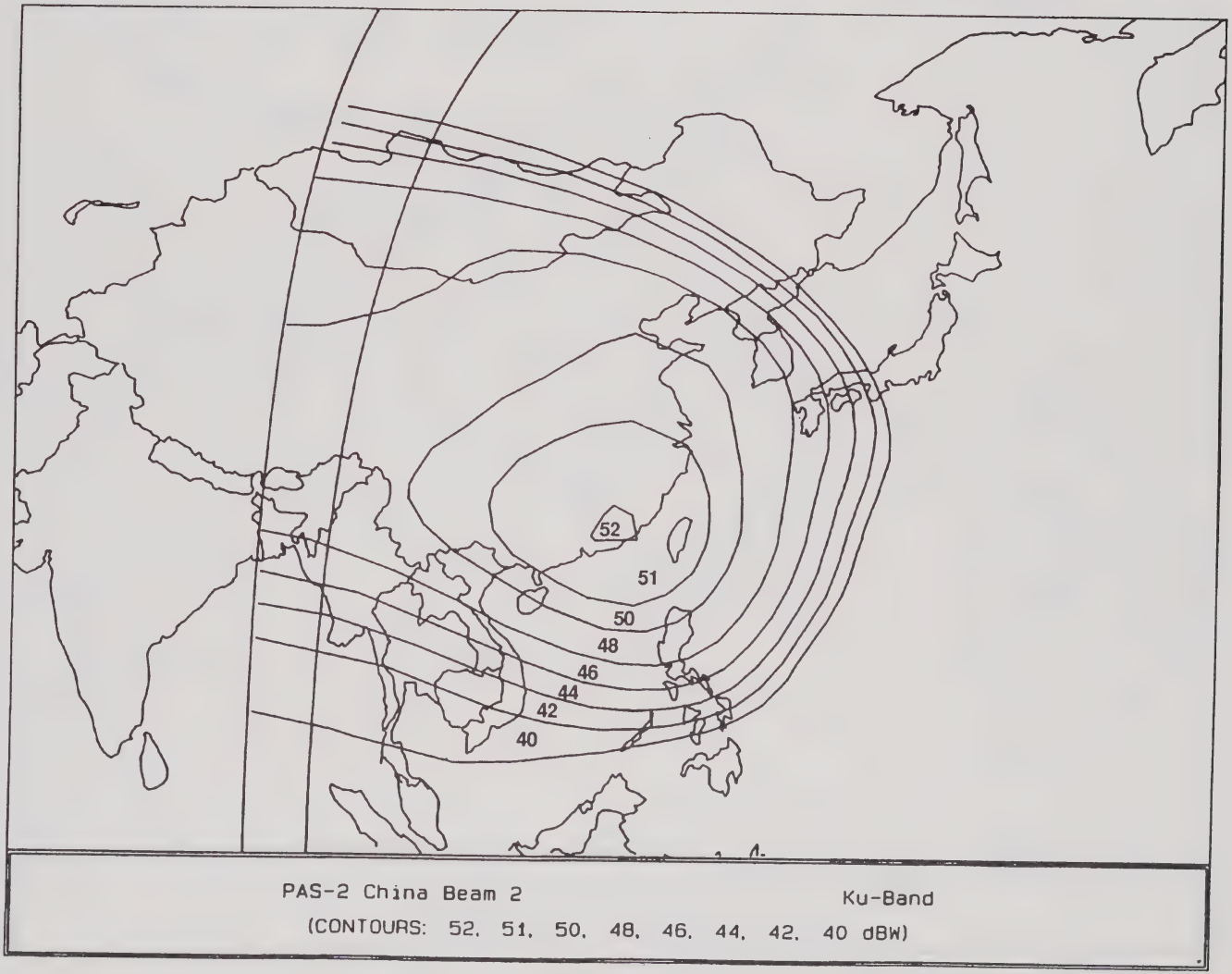
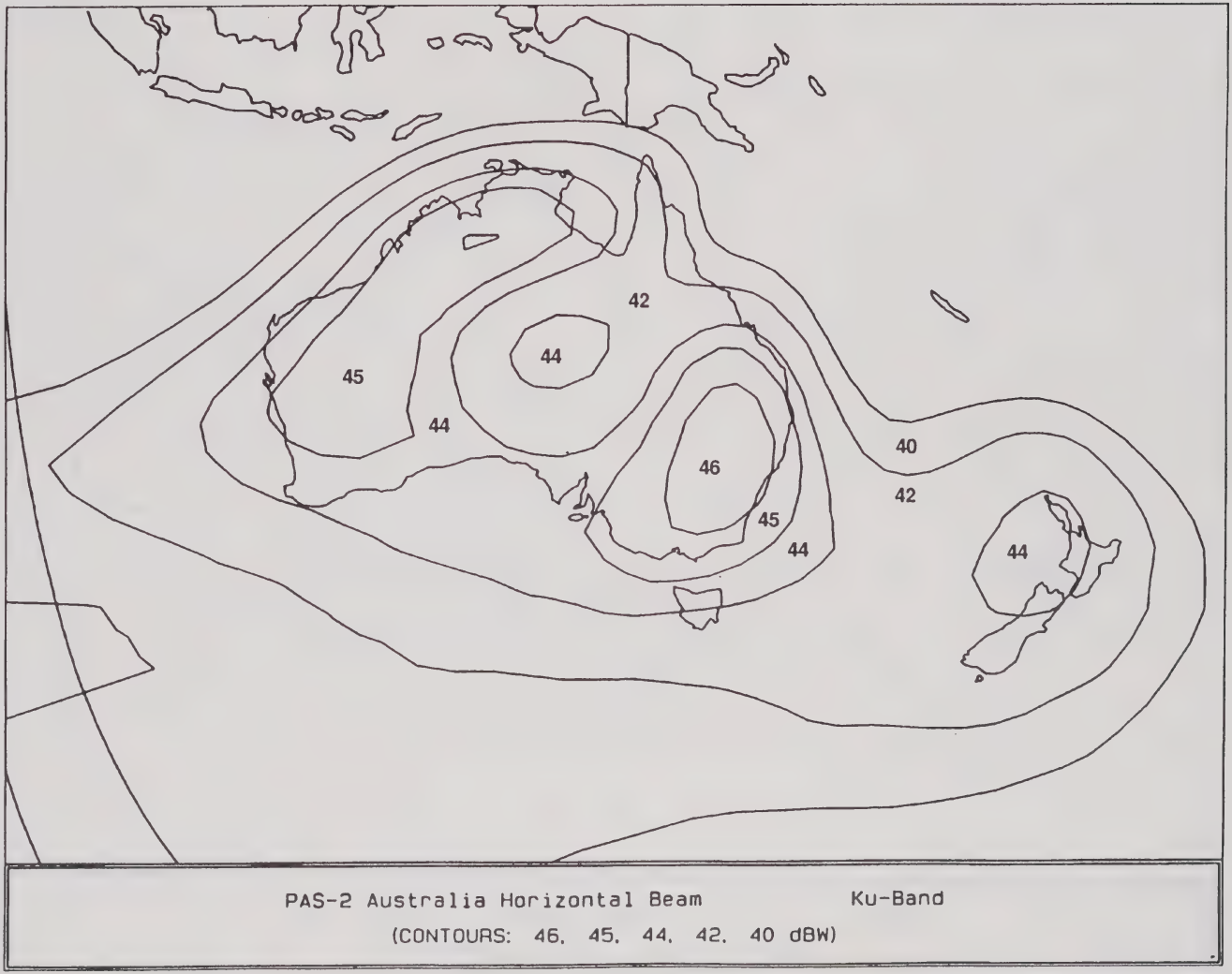
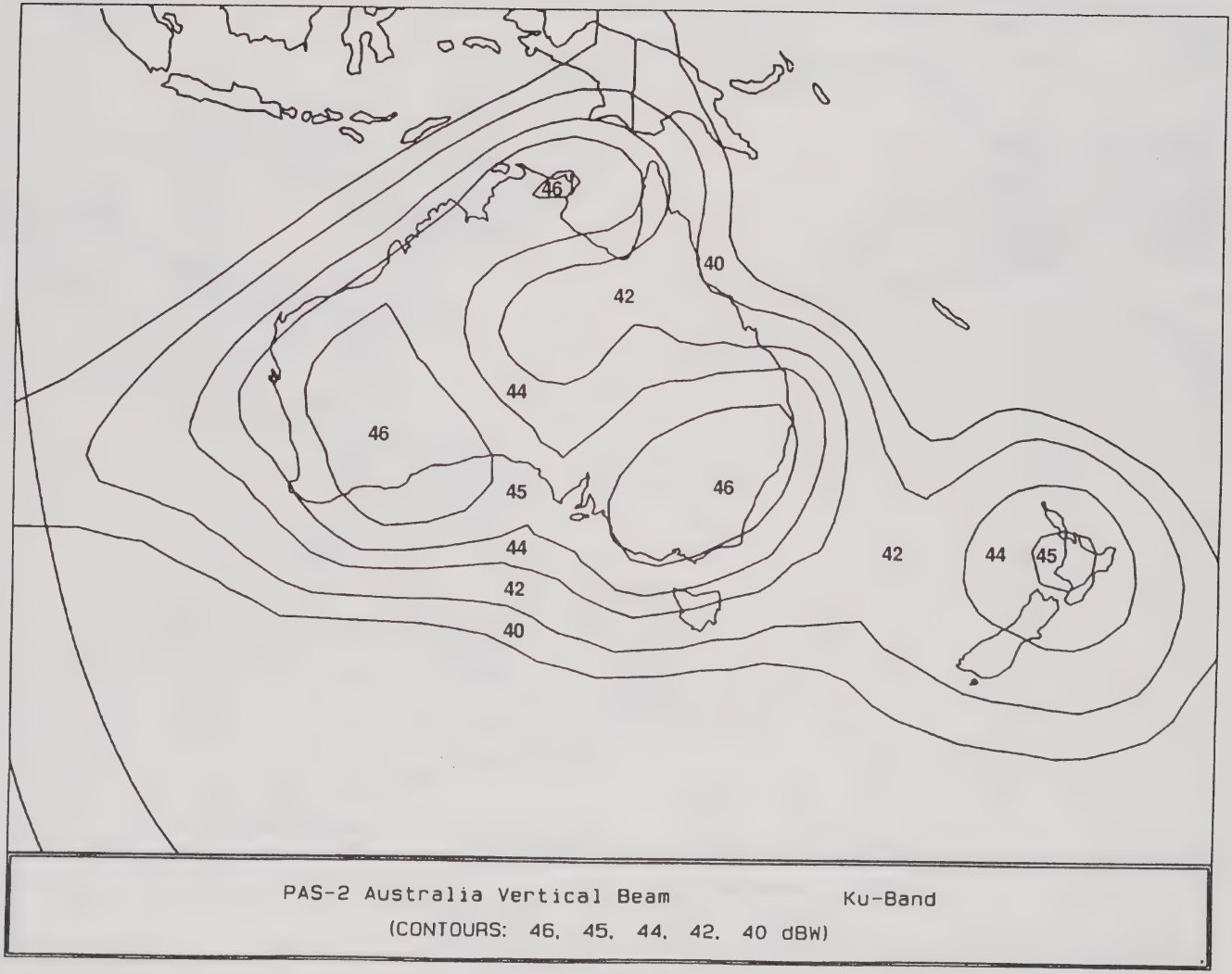
PAS-2 Northeast Asia Beam
Ku-Band
(CONTOURS: 50, 49, 48, 46, 44, 42, 40 dBW)


50
48
46
44
42
40
51
52
PAS-2 China Beam 1
Ku-Band
(CONTOURS: 52, 51, 50, 48, 46, 44, 42, 40 dBW)


52
51
50
48
46
44
42
40
PAS-2 China Beam 2
Ku-Band
(CONTOURS: 52, 51, 50, 48, 46, 44, 42, 40 dBW)

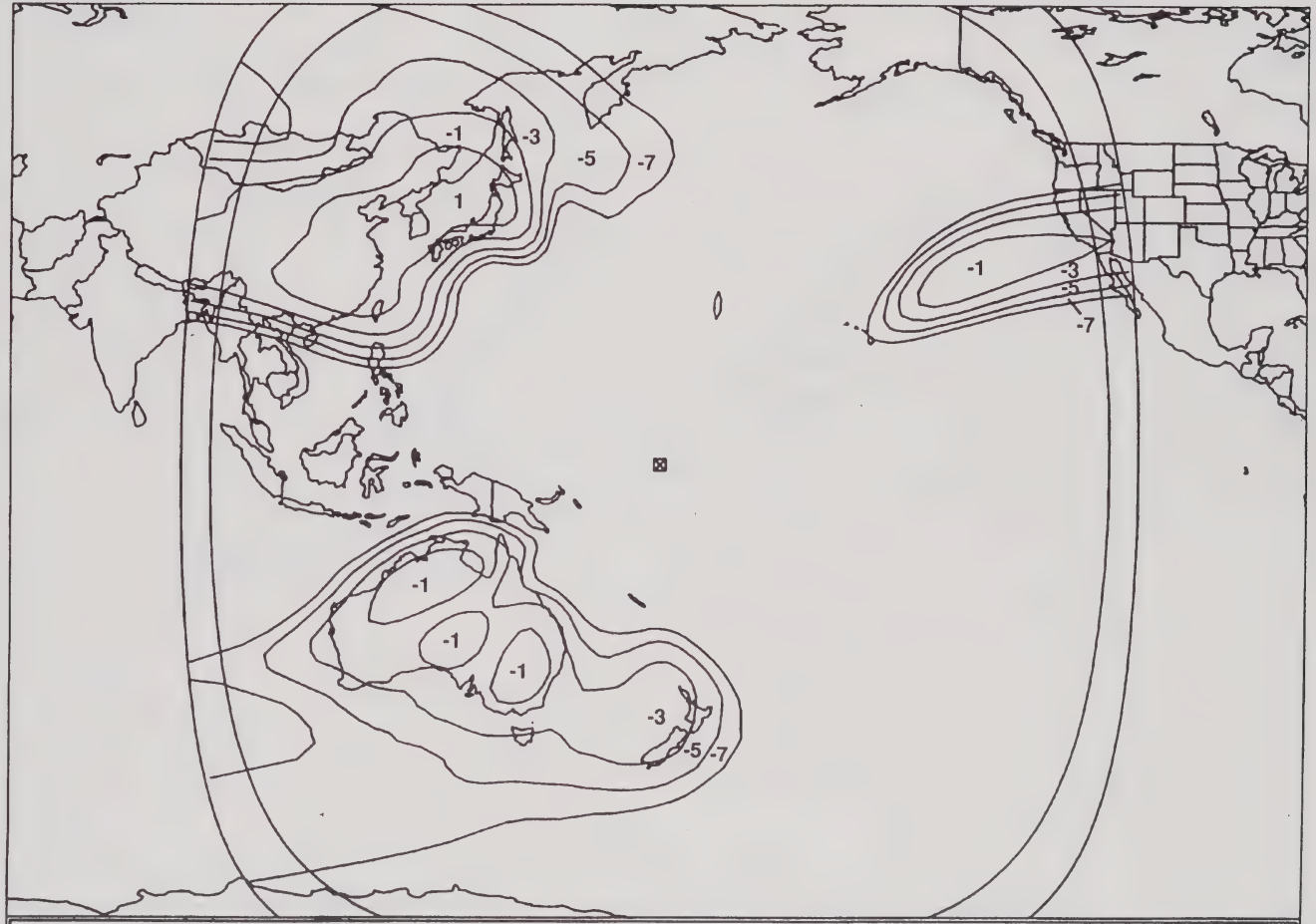


PAS-2 Australia Horizontal Beam Ku-Band
(CONTOURS: 46, 45, 44, 42, 40 dBW)

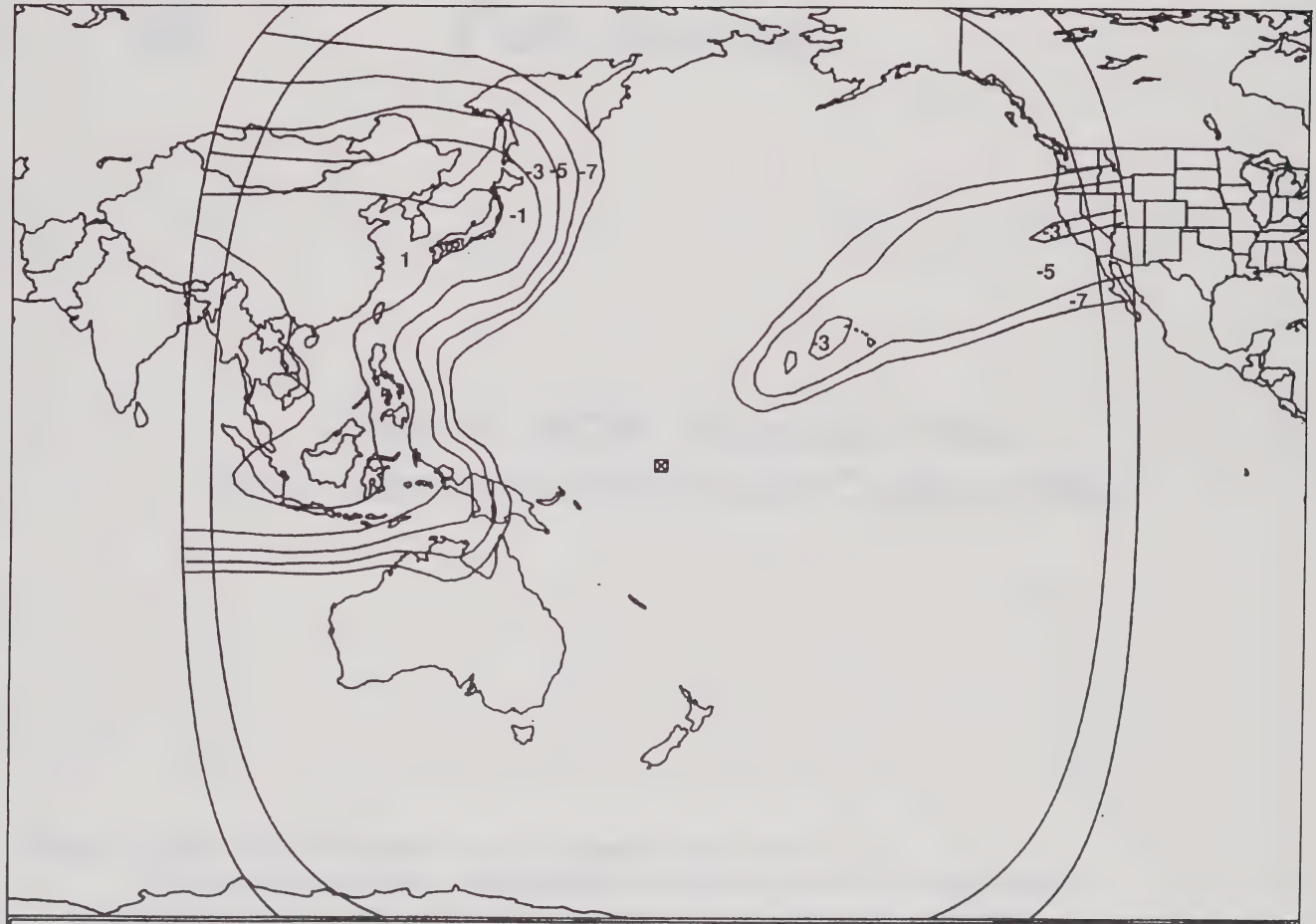


PAS-2 Australia Vertical Beam Ku-Band

(CONTOURS: 46, 45, 44, 42, 40 dBW)



PAS-2 Asia/Australia Horiz. Uplink Beam Ku-Band
(CONTOURS: 1, -1, -3, -5, -7 dB/K)



PAS-2 Asia Vertical Uplink Beam Ku-Band

(CONTOURS: 1, -1, -3, -5, -7 dB/K)

PAS-3R (AOR) Frequency Plan Interconnection Matrix, and Contour Maps

Notes: 1) EIRP & G/T values are minimum expected end-of-life.
2) PAS recommends that 1.0dB additional margin be applied to values shown.
3) Zero and five degree elevation look angles are shown where applicable.

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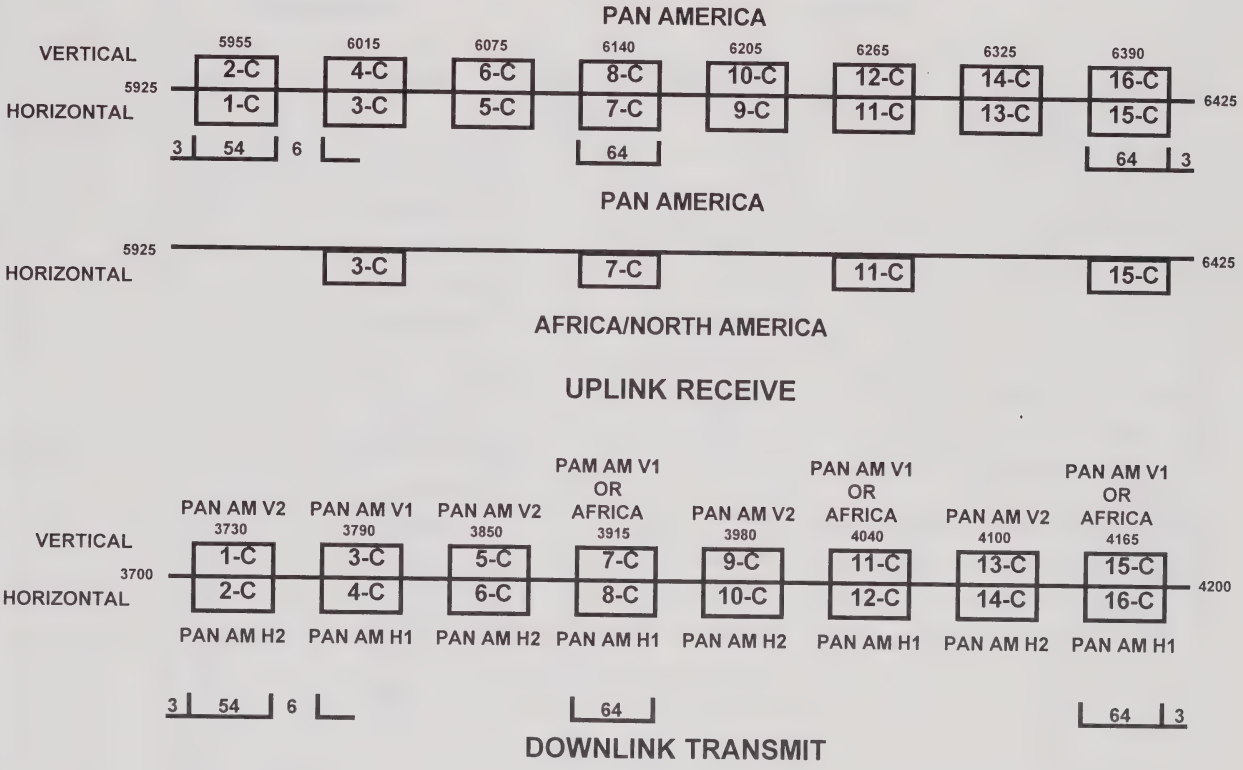
PAS-3R (AOR) C-Band Frequency Plan



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PAS-3R (AOR) C-Band Interconnection Matrix

Downlink			Uplink				
Channel	Pol	Coverage	C-Band Vert Pan Am Eastern US	C-Band Horiz Pan Am	C-Band Horiz Africa/N. Amer.	Ku-Band Vert Eur./N. Amer Mex./Carribean	Ku-Band Horiz. S. America
1-C	V	Pan America 2V		1-C		9-K	
3-C	V	Pan America 1V		3-C	3-C	11-K	
5-C	V	Pan America 2V		5-C		13-K	
7-C	V	Pan Am 1V or Africa		7-C	7-C	15-K	
9-C	V	Pan America 2V		9-C			
11-C	V	Pan Am 1V or Africa		11-C	11-C		
13-C	V	Pan America 2V		13-C			
15-C	V	Pan Am 1V or Africa		15-C	15-C		
2-C	H	Pan America 2H	2-C				9S-K
4-C	H	Pan America 1H	4-C				12S-K
6-C	H	Pan America 2H	6-C				13S-K
8-C	H	Pan America 1H	8-C				16S-K
10-C	H	Pan America 2H	10-C				
12-C	H	Pan America 1H	12-C				
14-C	H	Pan America 2H	14-C				
16-C	H	Pan America 1H	16-C				

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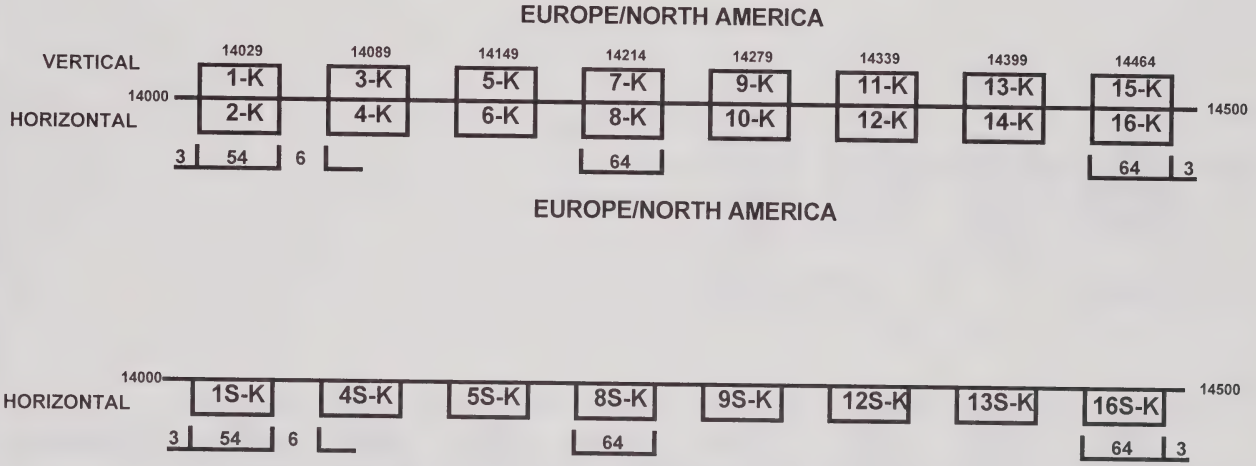
PAS-3R (AOR) Ku-Band Frequency Plan



UPLINK RECEIVE

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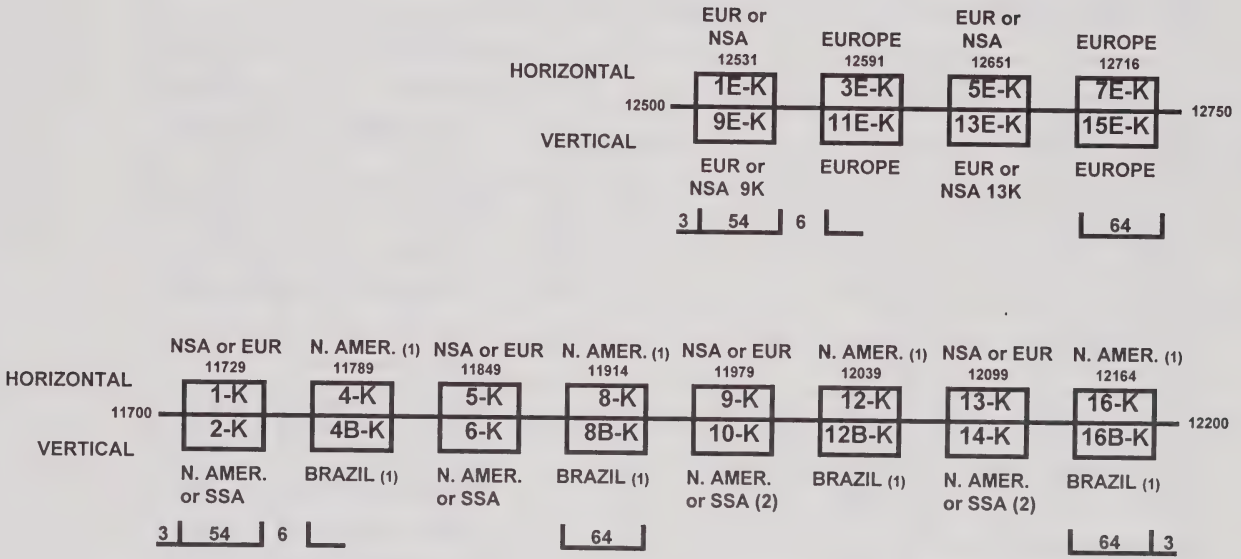
PAS-3R (AOR) Ku-Band Frequency Plan



DOWNLINK TRANSMIT

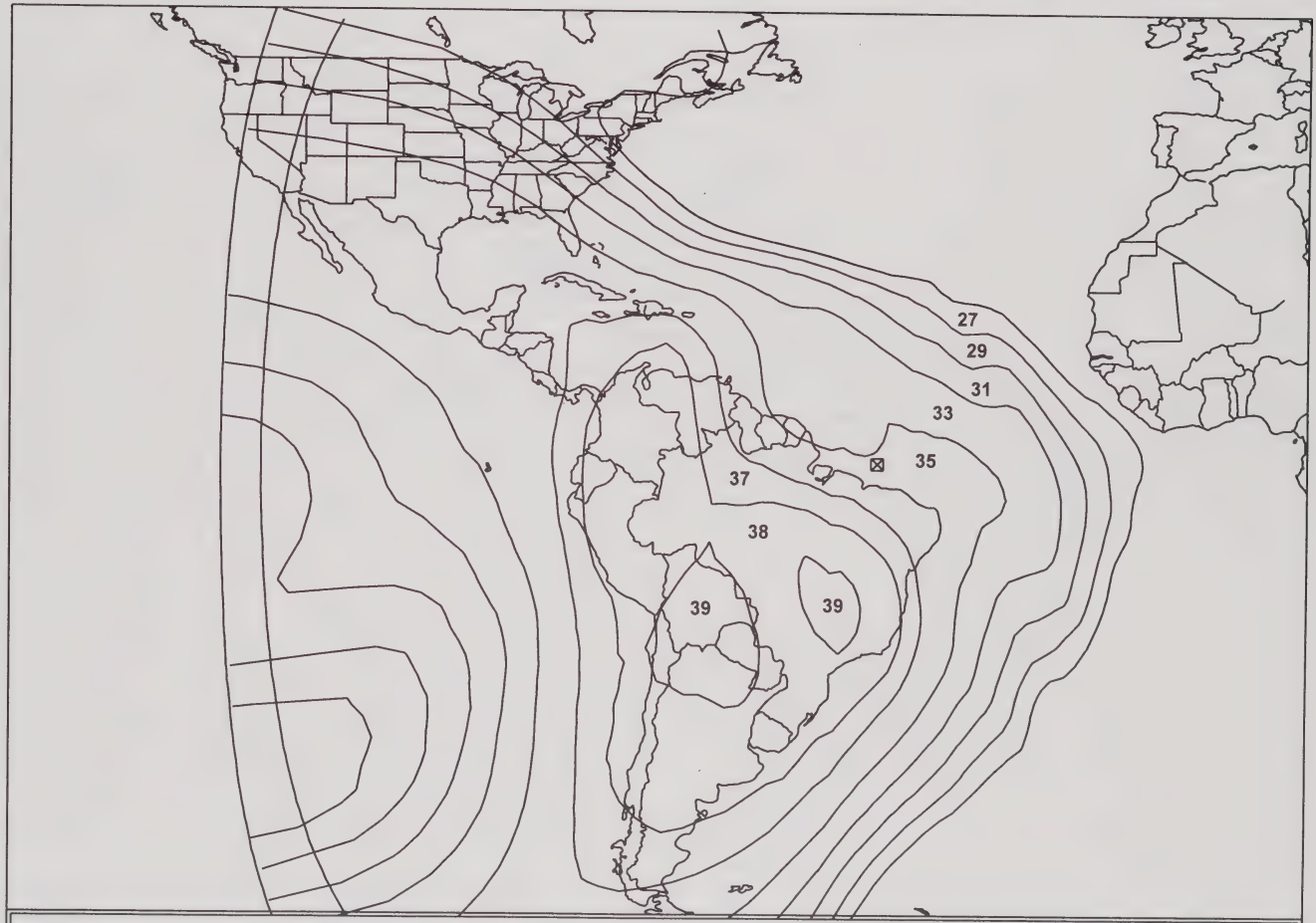
Notes: 1) Transponders 4, 8, 12, and 16 are selectable for either N. America or Brazil coverage.
2) Transponders 2-K, 6-K, 10-K and 14-K are transmitted horizontally when SSA coverage is selected

PanAmSat

PAS-3R (AOR) Ku-Band Interconnection Matrix

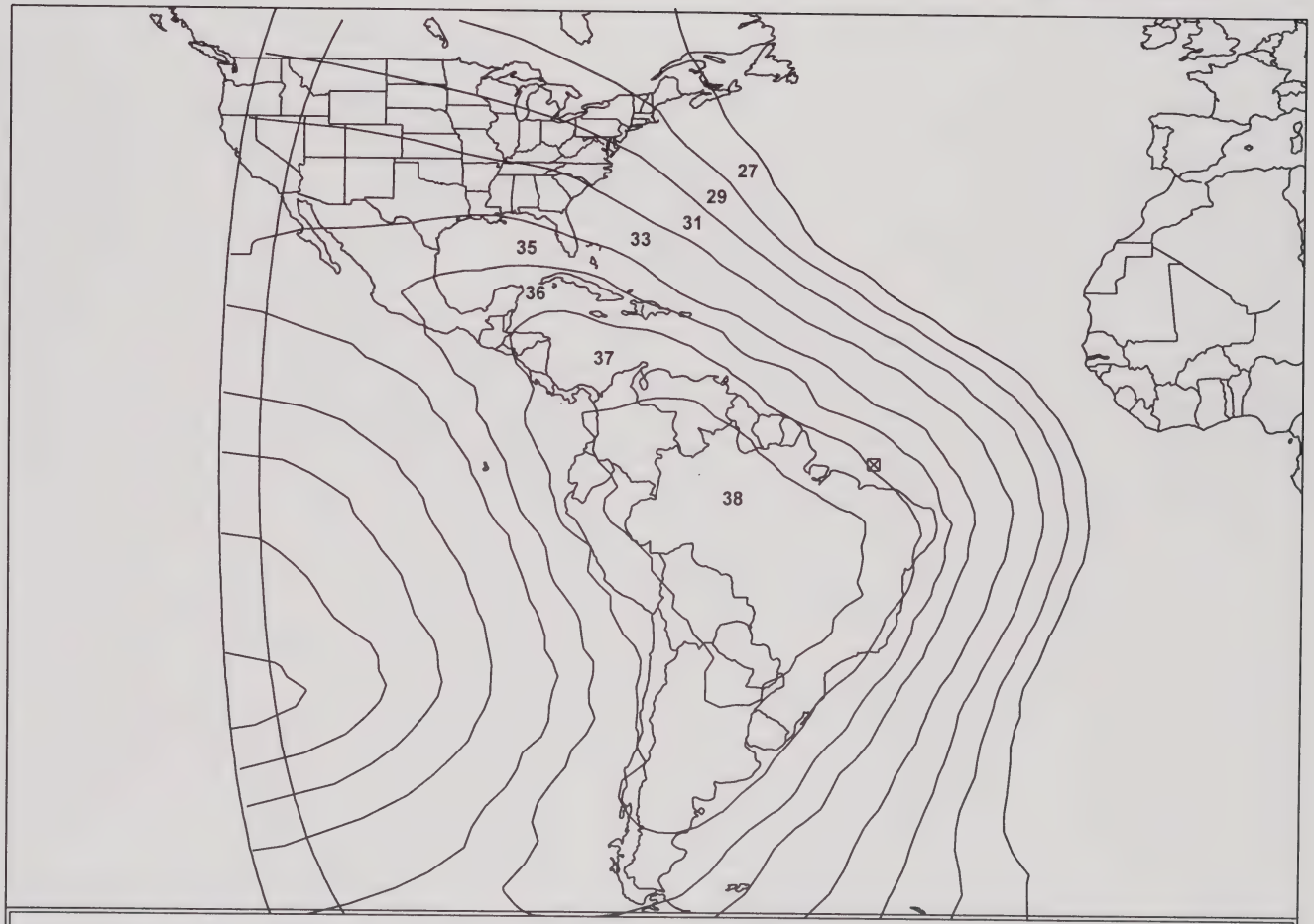
Downlink			Uplink				
Channel	Pol (1)	Coverage	Ku-Band Vert Eur./N. Amer.	Ku-Band Hor iz Eur./N. Amer.	Ku-Band Horiz S. America (2)	C-Band Vert Pan America	C-Band Horiz Pan America (3
1E-K or 1-K	H	Eur or NSA	1-K		1S-K		
3E-K	H	Europe	3-K				
5E-K or 5-K	H	Eur or NSA	5-K		5S-K		
7E-K	H	Europe	7-K				
9E-K or 9K	V or H	Eur or NSA	9-K		9S-K		1-C
11E-K	V	Europe	11-K				3-C
13E-K or 13-K	V or H	Eur or NSA	13-K		13S-K		5-C
15E-K	V	Europe	15-K				7-C
2-K	V or H	N Amer or SSA		2-K	1S-K		
4-K or 4B-K	H or V	N Amer or Brazil		4-K	4S-K		
6-K	V or H	N Amer or SSA		6-K			
8-K or 8B-K	H or V	N Amer or Brazil		8-K	8S-K		
10-K	V or H	N Amer or SSA		10-K		2-C	
12-K or 12B-K	H or V	N Amer or Brazil		12-K	12S-K	4-C	
14-K	V or H	N Amer or SSA		14-K		6-C	
16-K or 16B-K	H or V	N Amer or Brazil		16-K	16S-K	8-C	

Notes: (1) First polarization is associated with first channel and first coverage
(2) Ku-Band Horizontal S. America uplinks 1-K, 5-K, 9-K, and 13-K cannot access the Europe downlink.
(3) C-Band Horizontal Pan America uplinks 1-C and 5-C cannot access the NSA downlink.



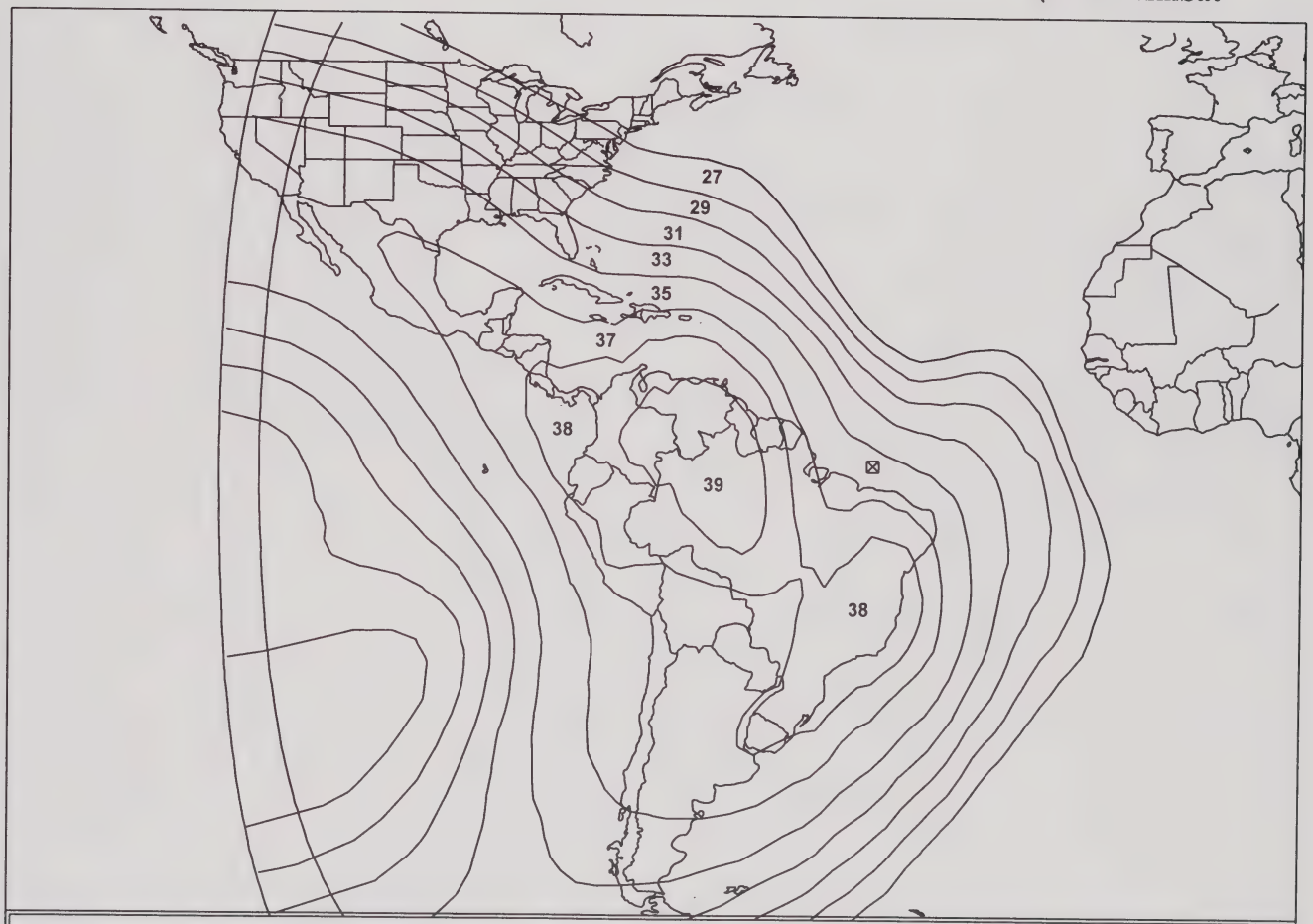
PAS-3R Pan America Horizontal Beam 1 C-Band

(CONTOURS: 39, 38, 37, 35, 33, 31, 29, 27 dBW)



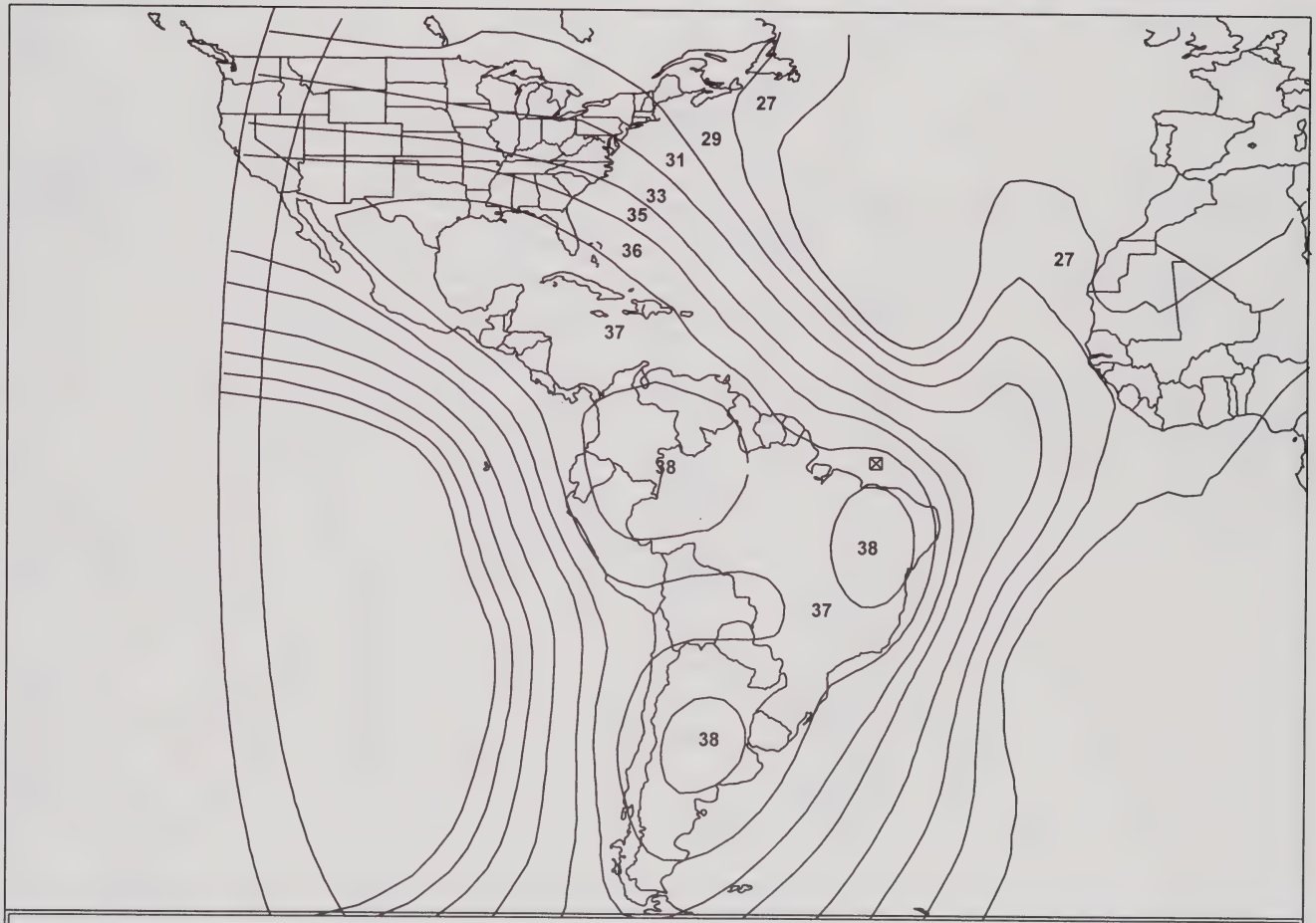
PAS-3R Pan America Horizontal Beam 2 C-Band

(CONTOURS: 38, 37, 36, 35, 33, 31, 29, 27 dBW)



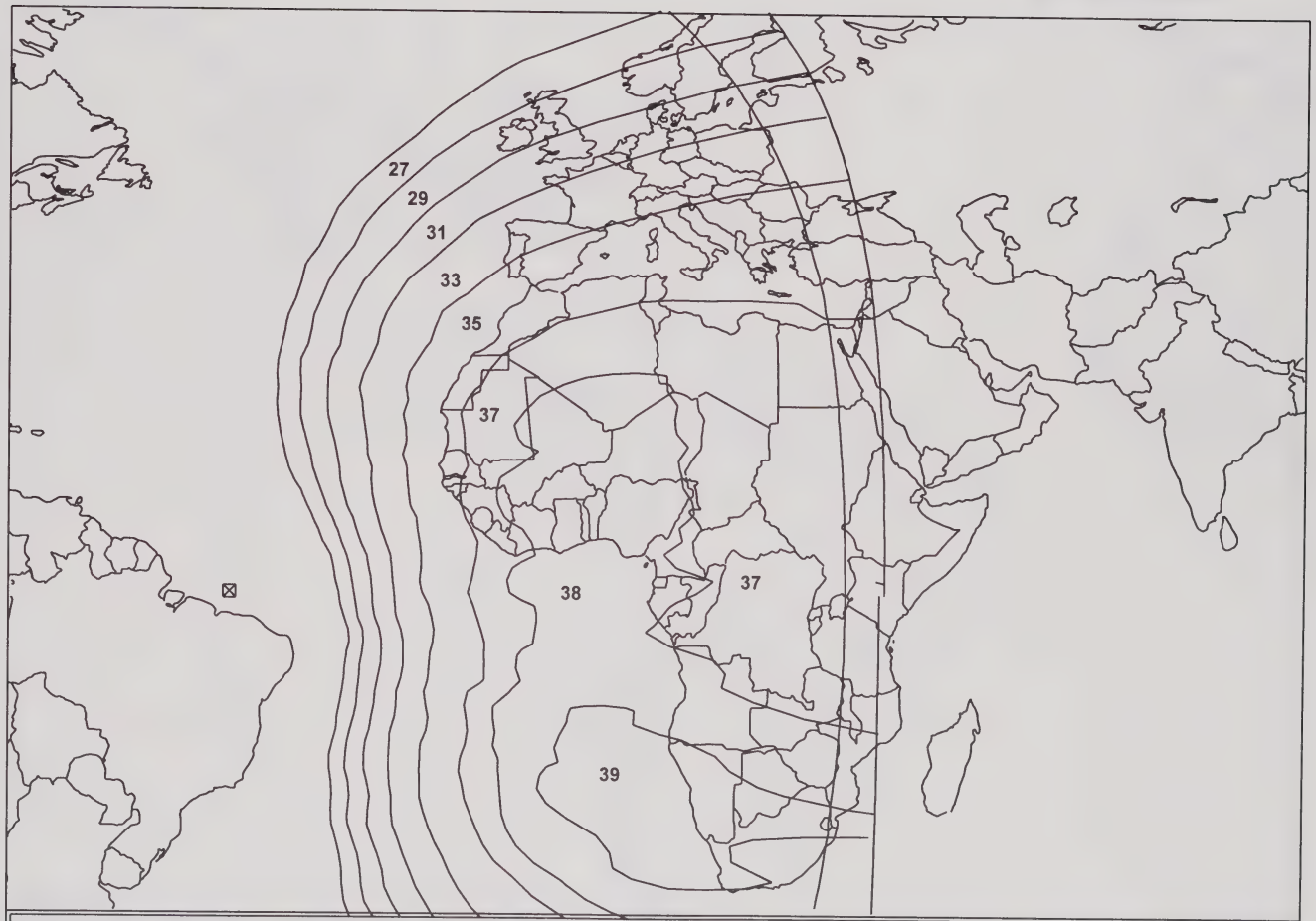
PAS-3R Pan America Vertical Beam 1 C-Band

(CONTOURS: 39, 38, 37, 35, 33, 31, 29, 27 dBW)



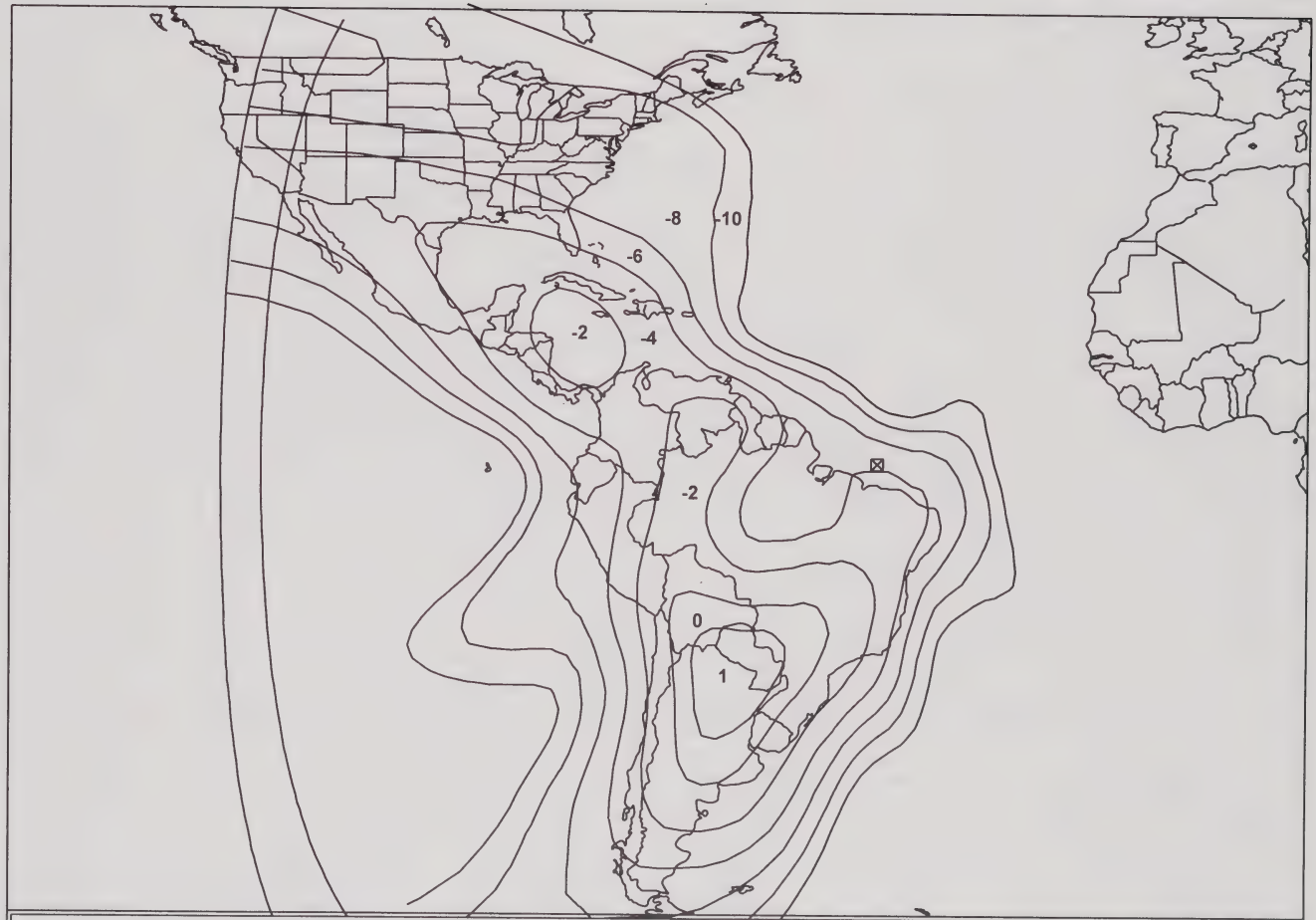
PAS-3R Pan America Vertical Beam 2 C-Band

(CONTOURS: 38, 37, 36, 35, 33, 31, 29, 27 dBW)



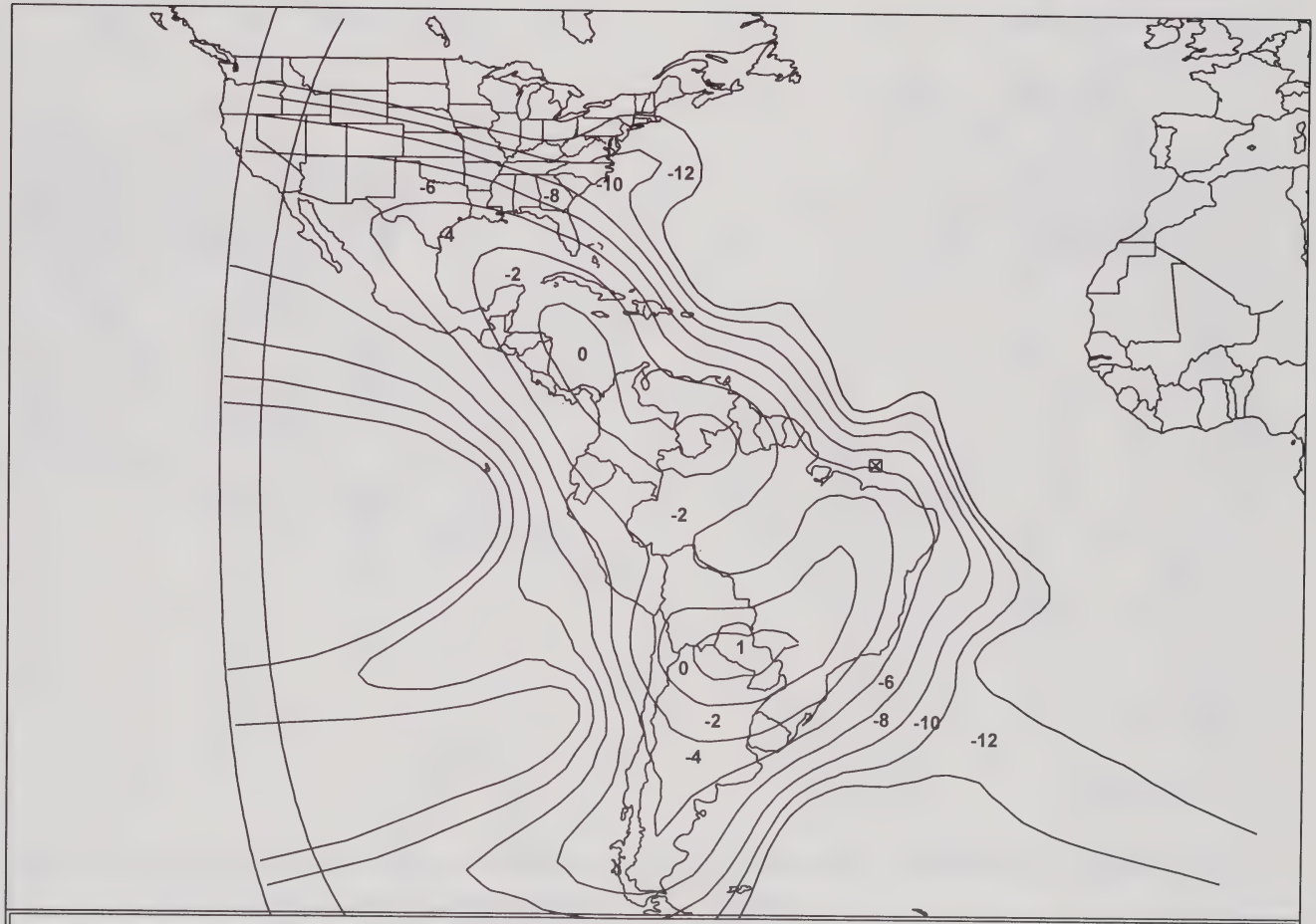
PAS-3R Africa Beam V C-Band

(CONTOURS: 39, 38, 37, 35, 33, 31, 29, 27 dBW)



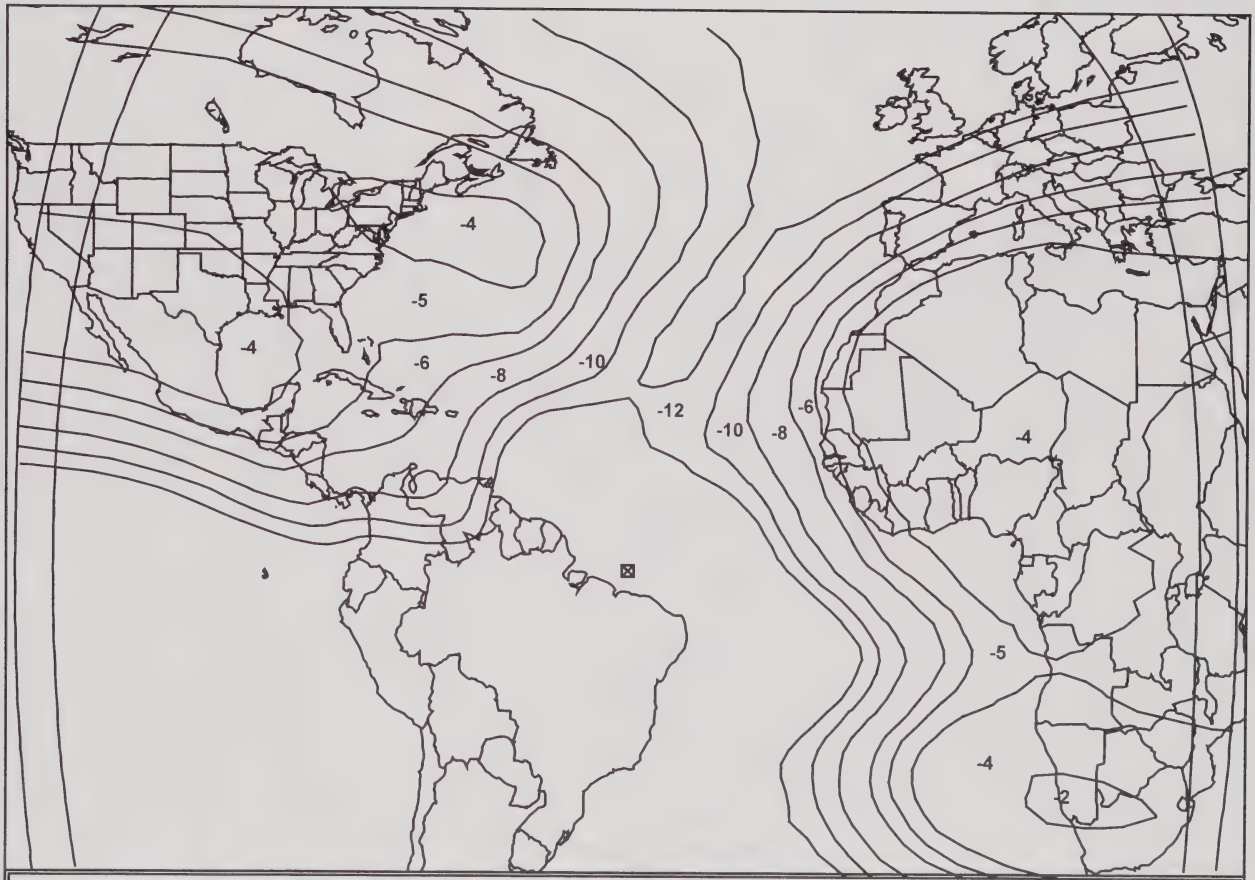
PAS-3R Pan America Horizontal Uplink Beam C-Band

(CONTOURS: 1, 0,-2,-4,-6,-8,-10 dB/K)



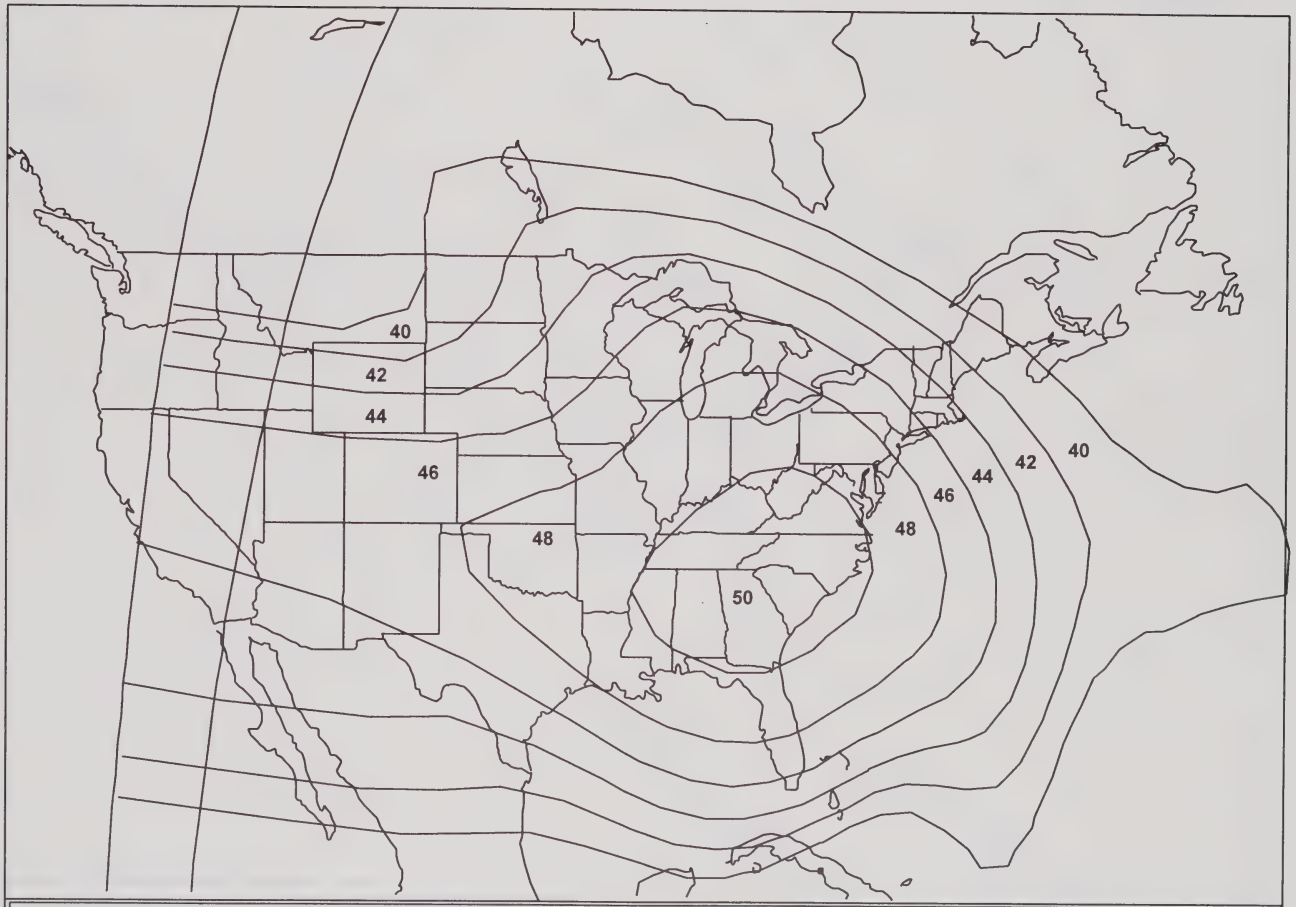
PAS-3R Pan America Vertical Uplink Beam C-Band

(CONTOURS: 1, 0,-2,-4,-6,-8,-10,-12 dB/K)



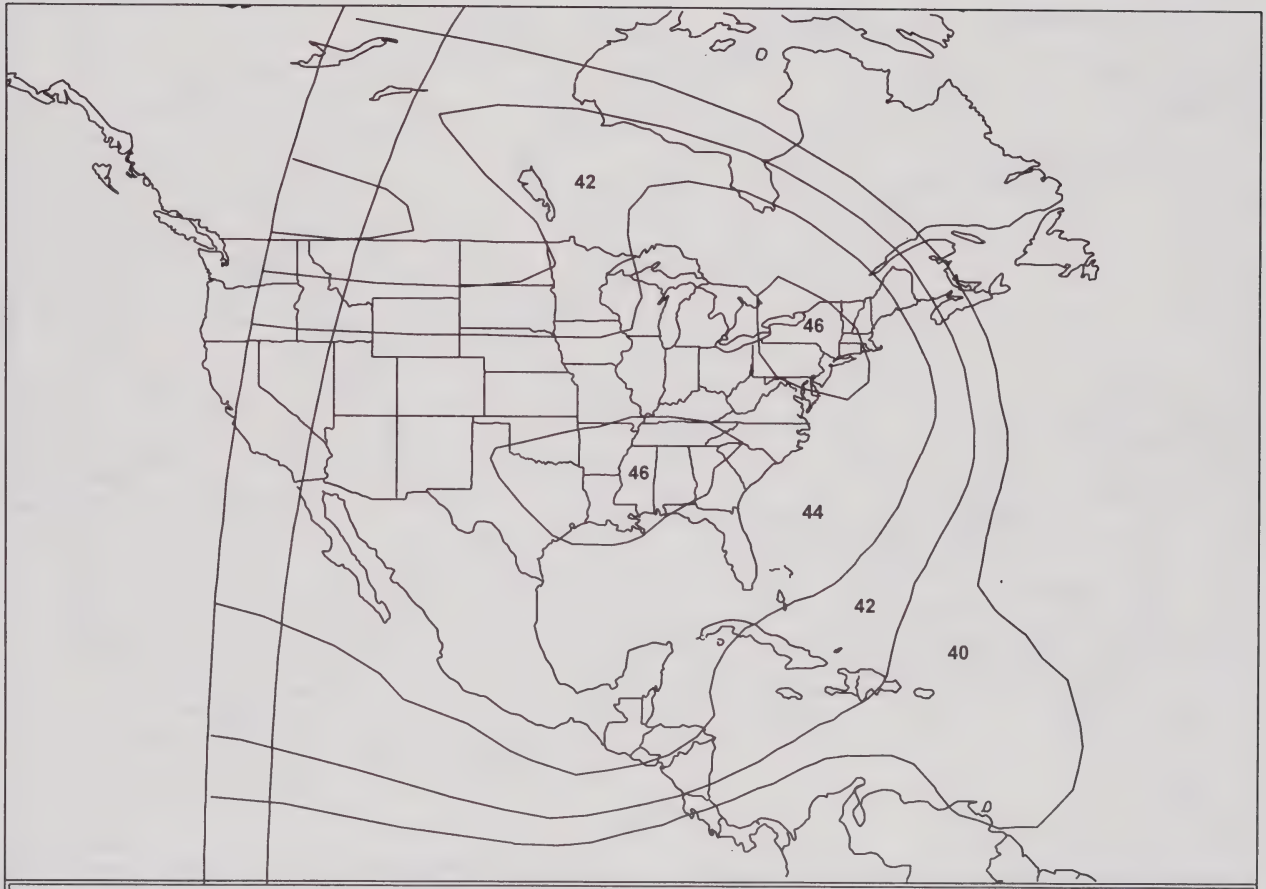
PAS-3R Africa/N. America Uplink Beam H C-Band

(CONTOURS:-2,-4,-5,-6,-8,-10,-12 dB/K)

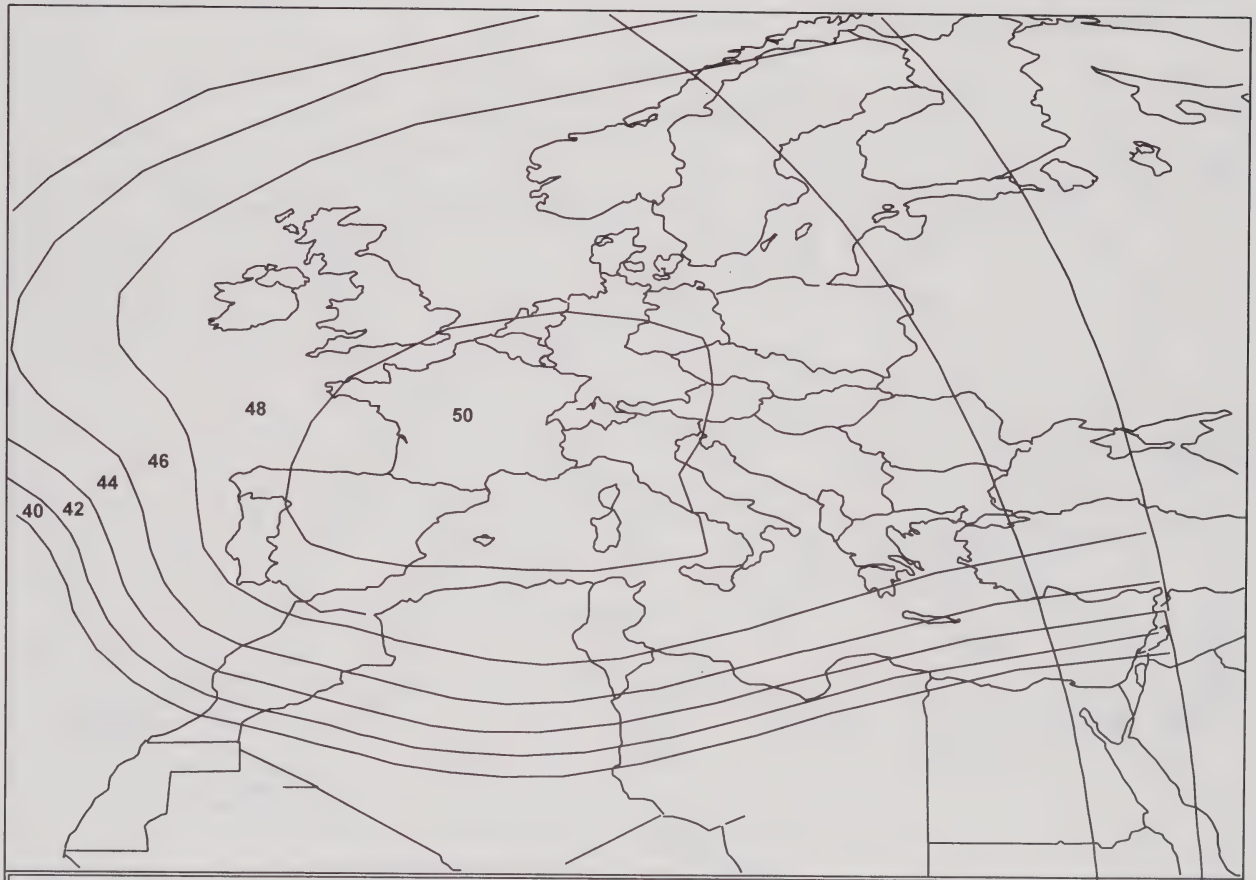


PAS-3R North America Horizontal Beam Ku-Band

(CONTOURS: 50, 48, 46, 44, 42, 40 dBW)

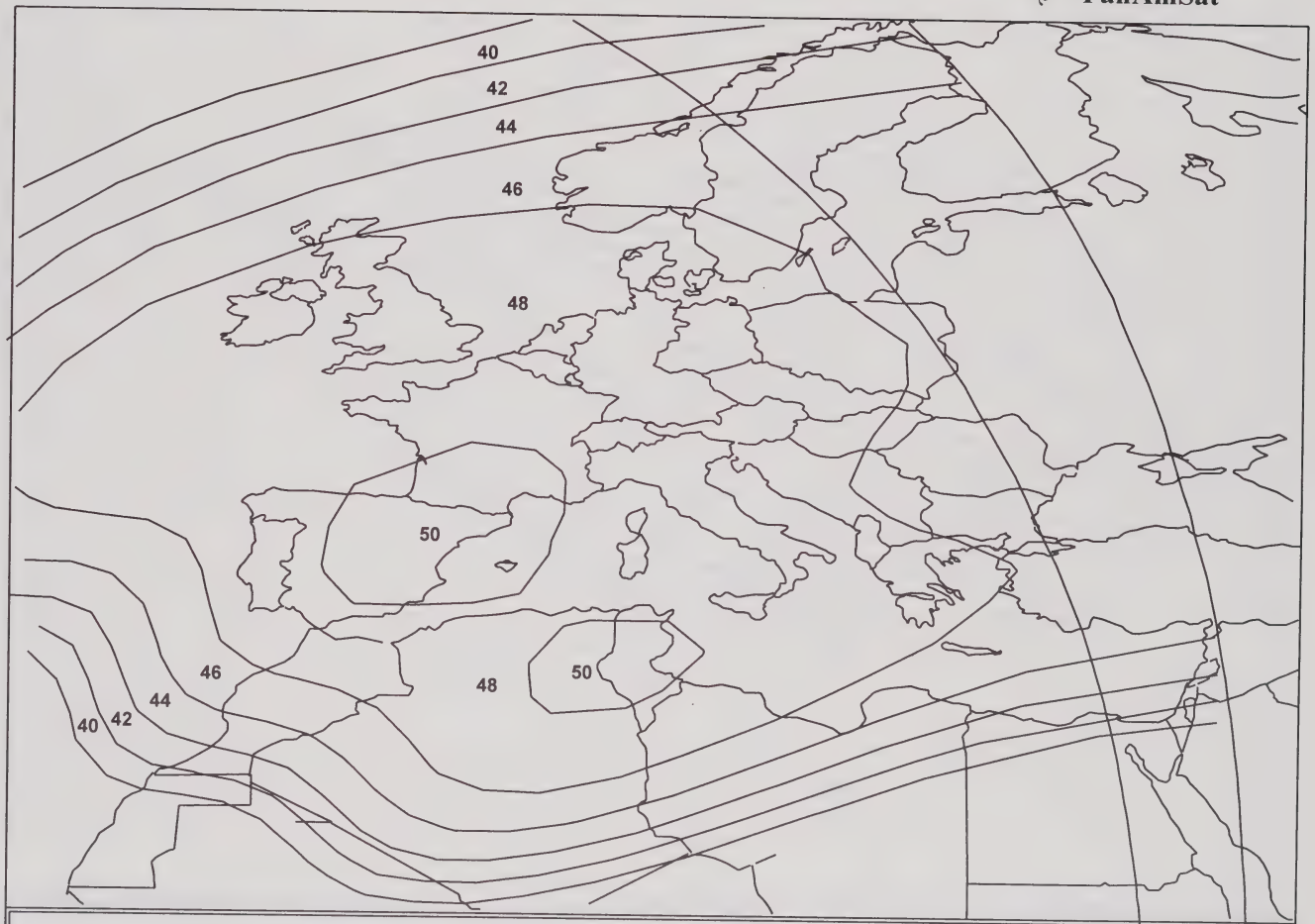


PAS-3R North America Vertical Beam Ku-Band
(CONTOURS: 46, 44, 42, 40 dBW)



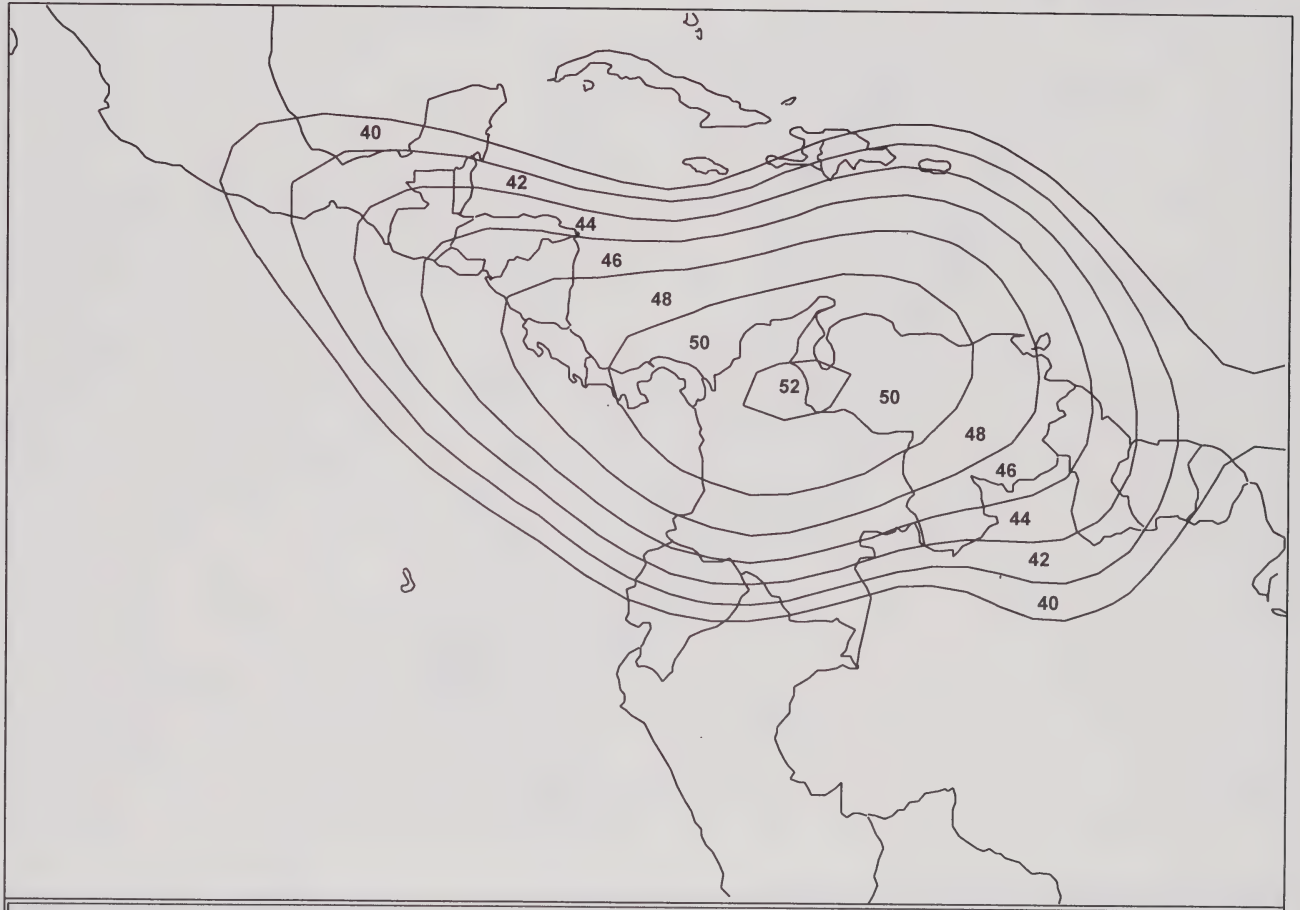
PAS-3R Europe Horizontal Beam Ku-Band

(CONTOURS: 50, 48, 46, 44, 42, 40 dBW)



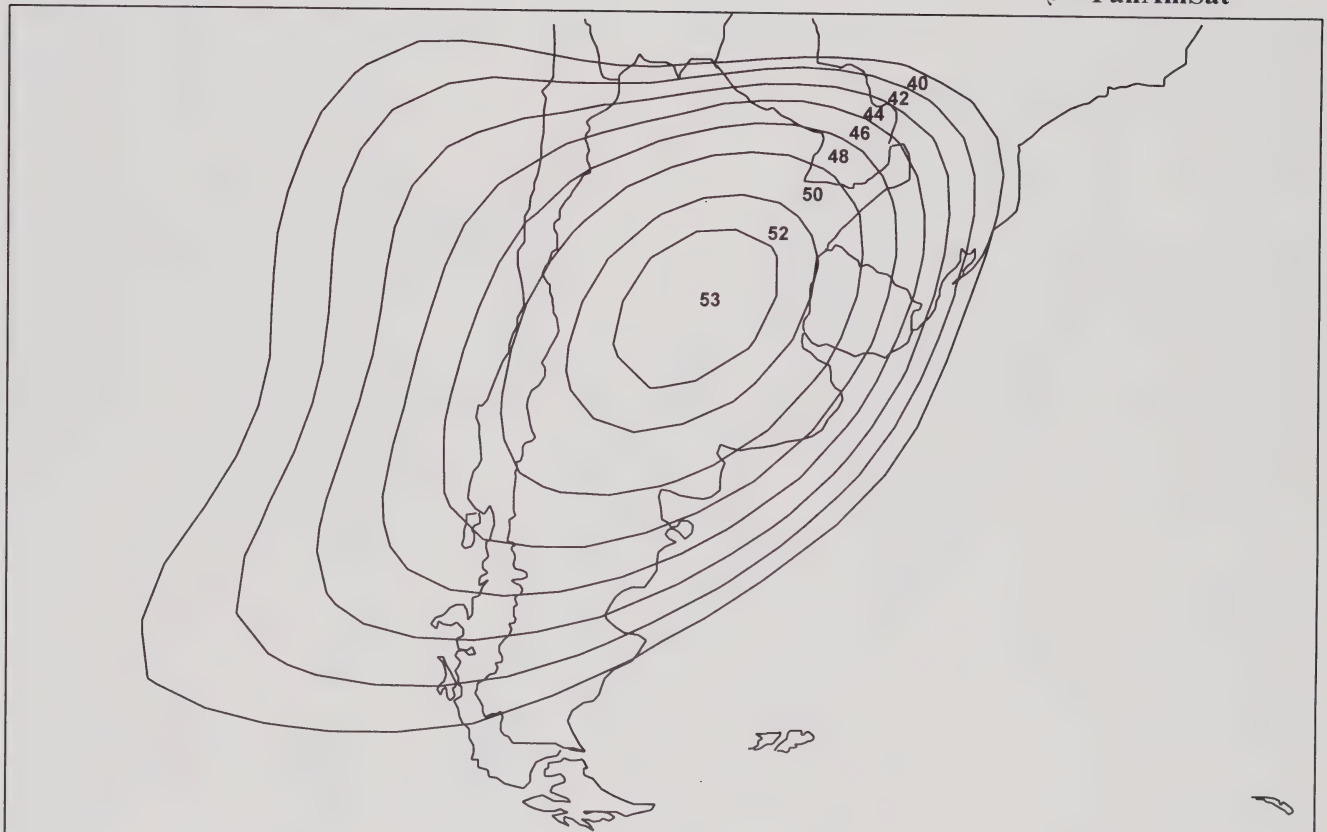
PAS-3R Europe Vertical Beam Ku-Band

(CONTOURS: 50, 48, 46, 44, 42, 40 dBW)



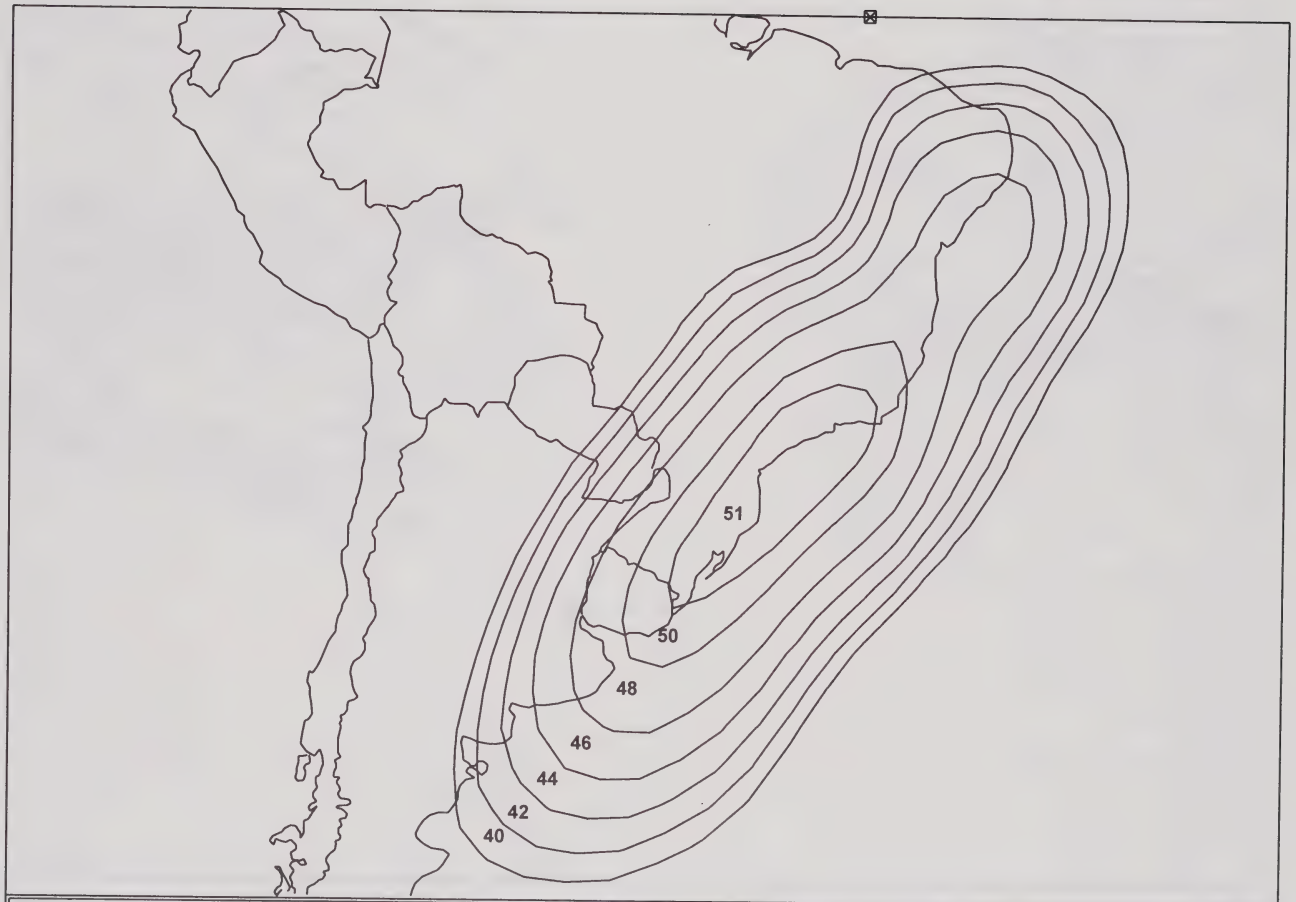
PAS-3R No. South America Beam H Ku-Band

(CONTOURS: 52, 50, 48, 46, 44, 42, 40 dBW)



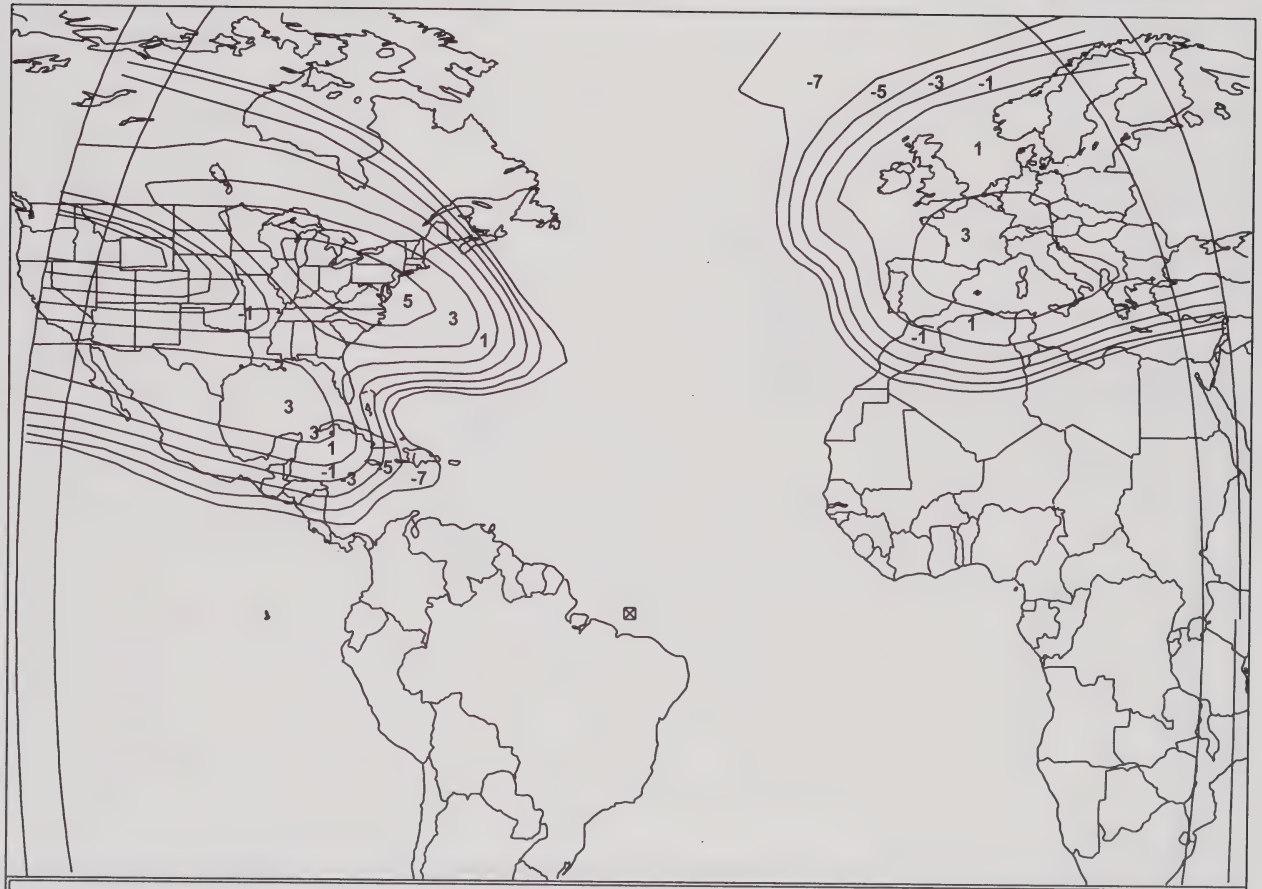
PAS-3R So. South America Beam H Ku-Band

(CONTOURS: 53, 52, 50, 48, 46, 44, 42, 40 dBW)

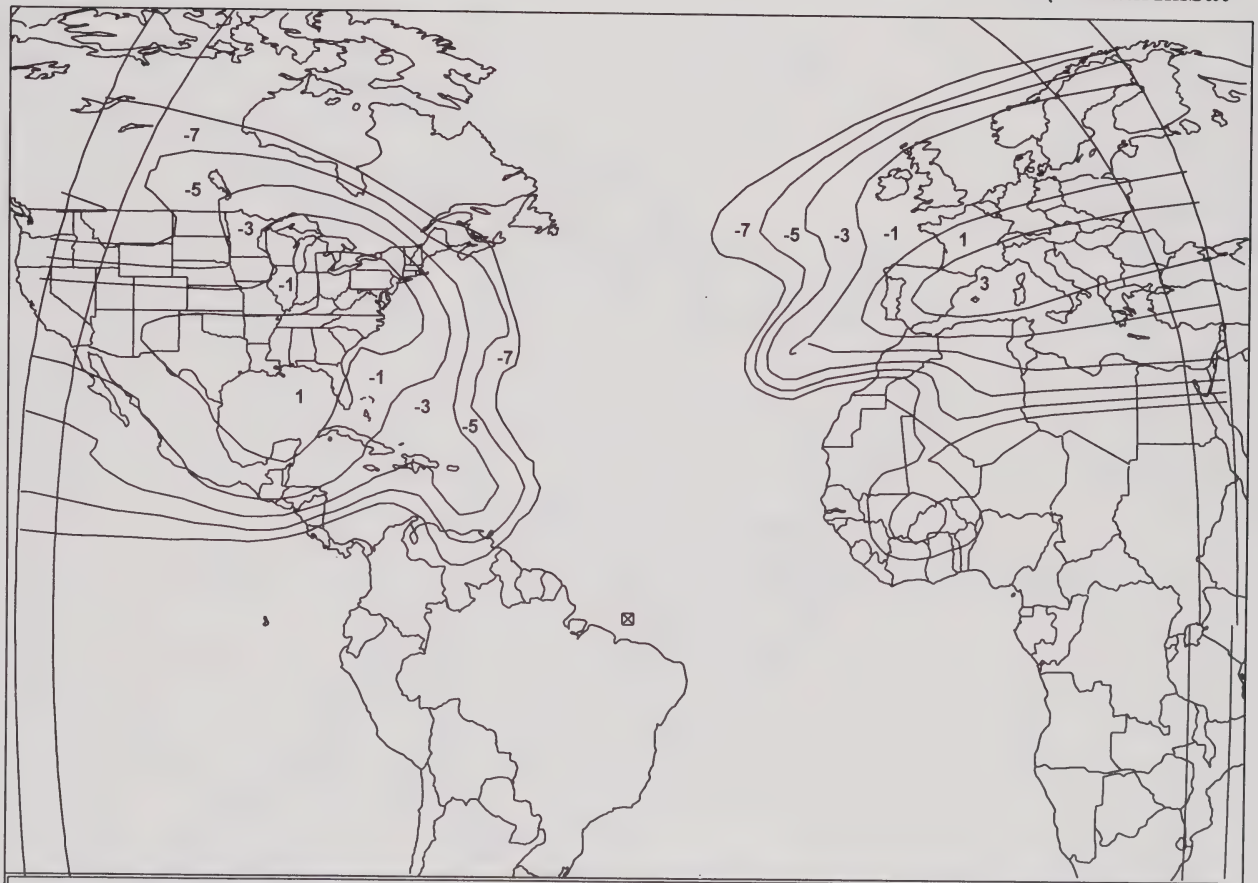


PAS-3R Brazil Beam V Ku-Band

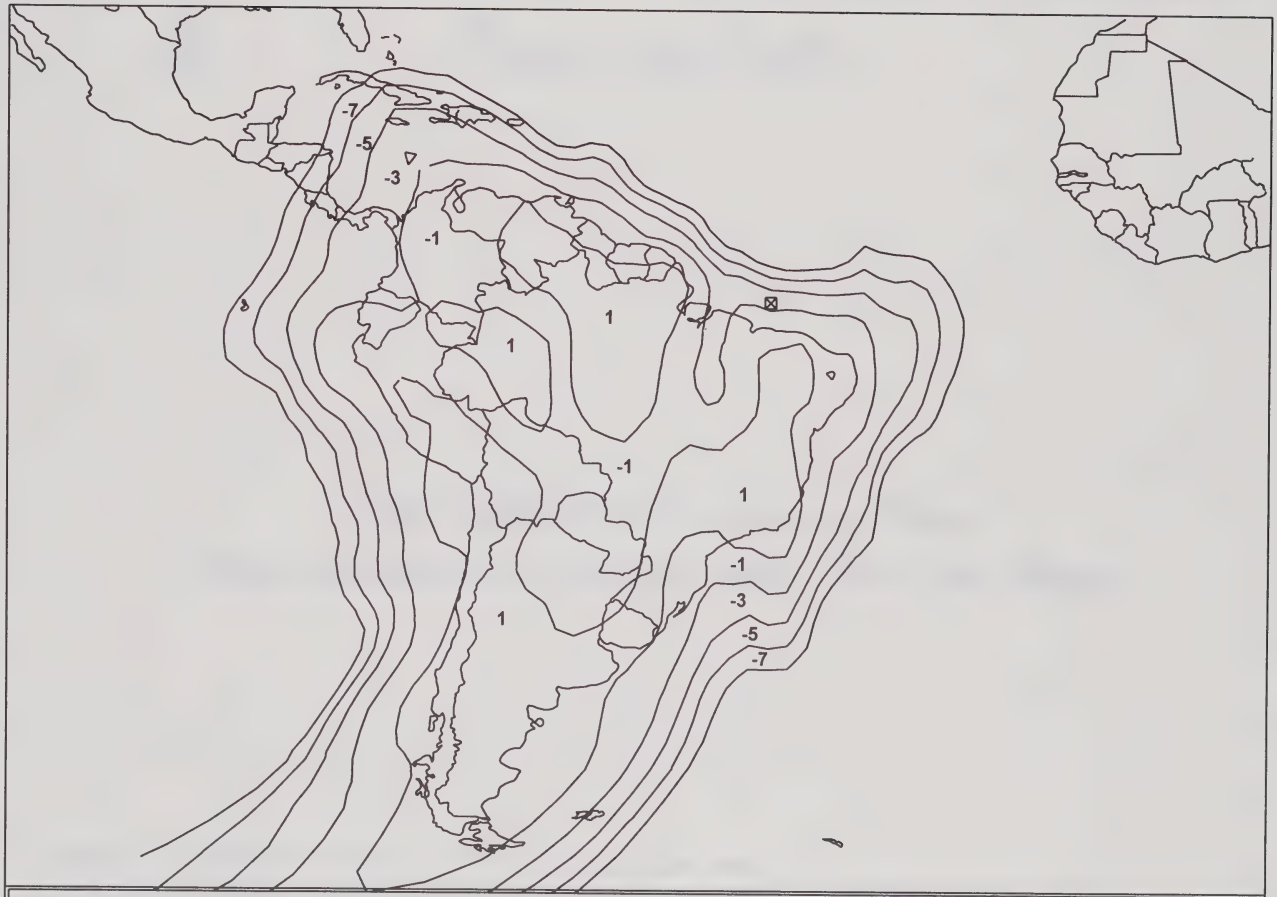
(CONTOURS: 51, 50, 48, 46, 44, 42, 40 dBW)



PAS-3R Europe/N. Amer. Horizontal Uplink Beam Ku-Band
(CONTOURS: 5, 3, 1,-1,-3,-5,-7 dB/K)



PAS-3R Europe/N. Amer. Vertical Uplink Beam Ku-Band
(CONTOURS: 3, 1,-1,-3,-5,-7 dB/K)



PAS-3R South America Uplink Beam H Ku-Band

(CONTOURS: 1,-1,-3,-5,-7 dB/K)

PAS-4 (IOR) Frequency Plan Interconnection Matrix, and Contour Maps

Notes: 1) EIRP & G/T values are minimum expected end-of-life.
2) PAS recommends that 0.5dB additional margin be applied to values shown.
3) Zero and five degree elevation look angles are shown where applicable

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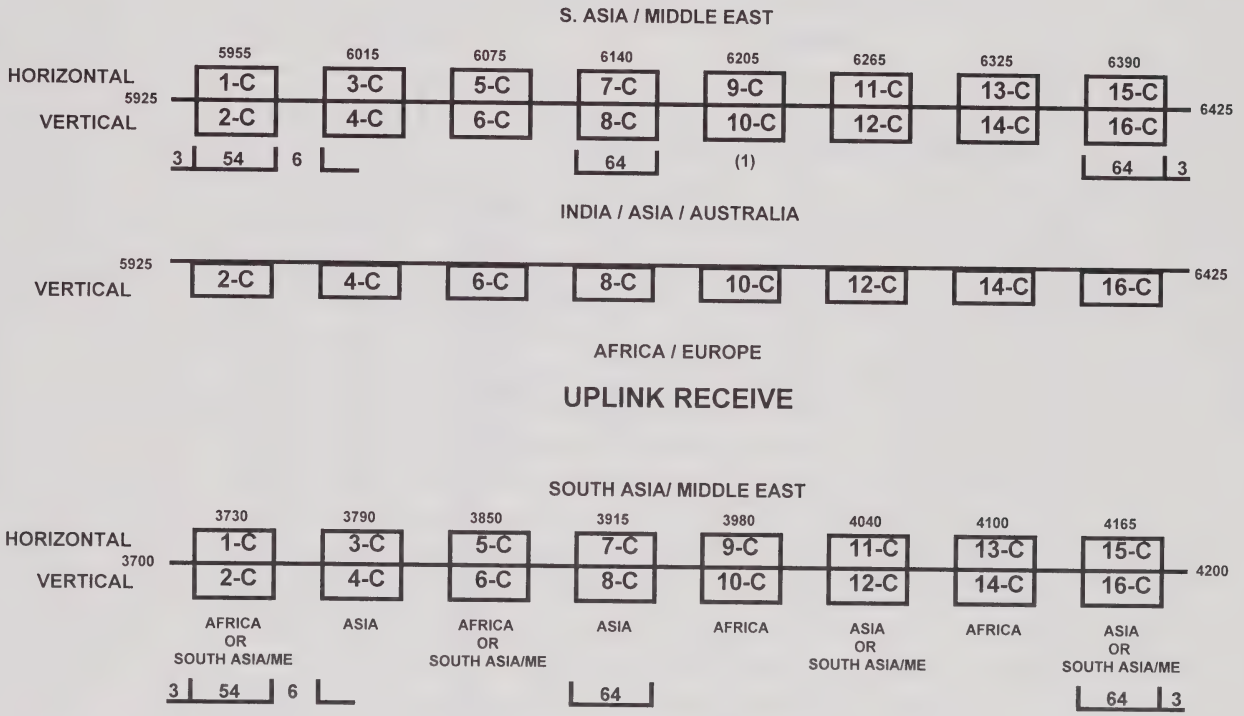
PAS-4 (IOR) C-Band Frequency Plan



Note: 1) 10-C not available for India/Asia/Australia uplink

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PAS-4 (IOR) C-Band Interconnection Matrix

Downlink			Uplink			
Channel	Pol	Coverage	C-Band Horiz S. Asia/ME	C-Band Vert India/Asia/Aust	C-Band Vert Africa/Eur	Ku-Band Vert Eur/S. Afr./Asia
1-C	H	S. Asia/ME	1-C			
3-C	H	S. Asia/ME	3-C			
5-C	H	S. Asia/ME	5-C			
7-C	H	S. Asia/ME	7-C			
9-C	H	S. Asia/ME	9-C			
11-C	H	S. Asia/ME	11-C			
13-C	H	S. Asia/ME	13-C			
15-C	H	S. Asia/ME	15-C			
2-C	V	S. Asia/ME or Africa		2-C	2-C	5-K
4-C	V	Asia		4-C	4-C	6-K
6-C	V	S. Asia/ME or Africa		6-C	6-C	7-K
8-C	V	Asia		8-C	8-C	8-K
10-C	V	Africa			10-C	
12-C	V	S. Asia/ME or Asia		12-C		
14-C	V	Africa		14-C	14-C	
16-C	V	S. Asia/ME or Asia		16-C	16-C	

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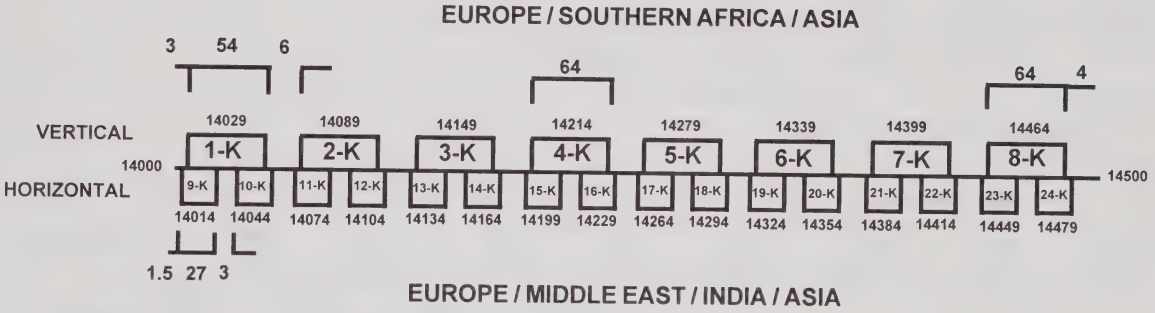
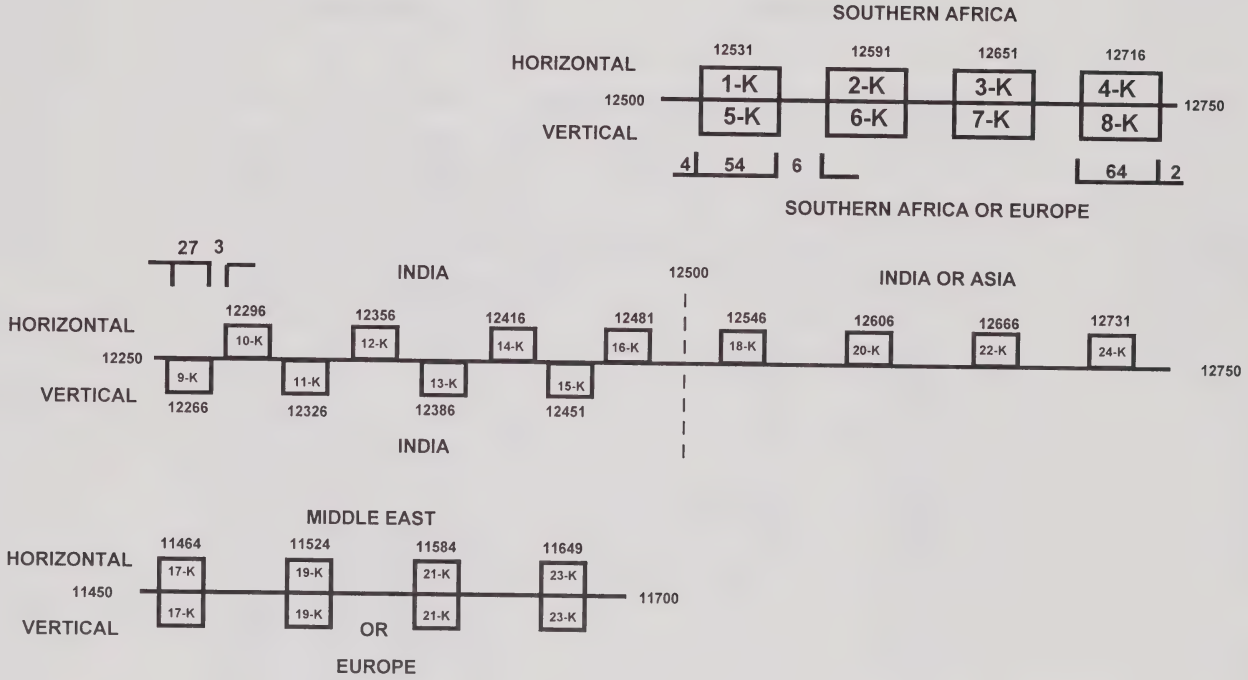
PAS-4 (IOR) Ku-Band Frequency Plan



UPLINK RECEIVE

PanAmSat

PAS-4 (IOR) Ku-Band Frequency Plan



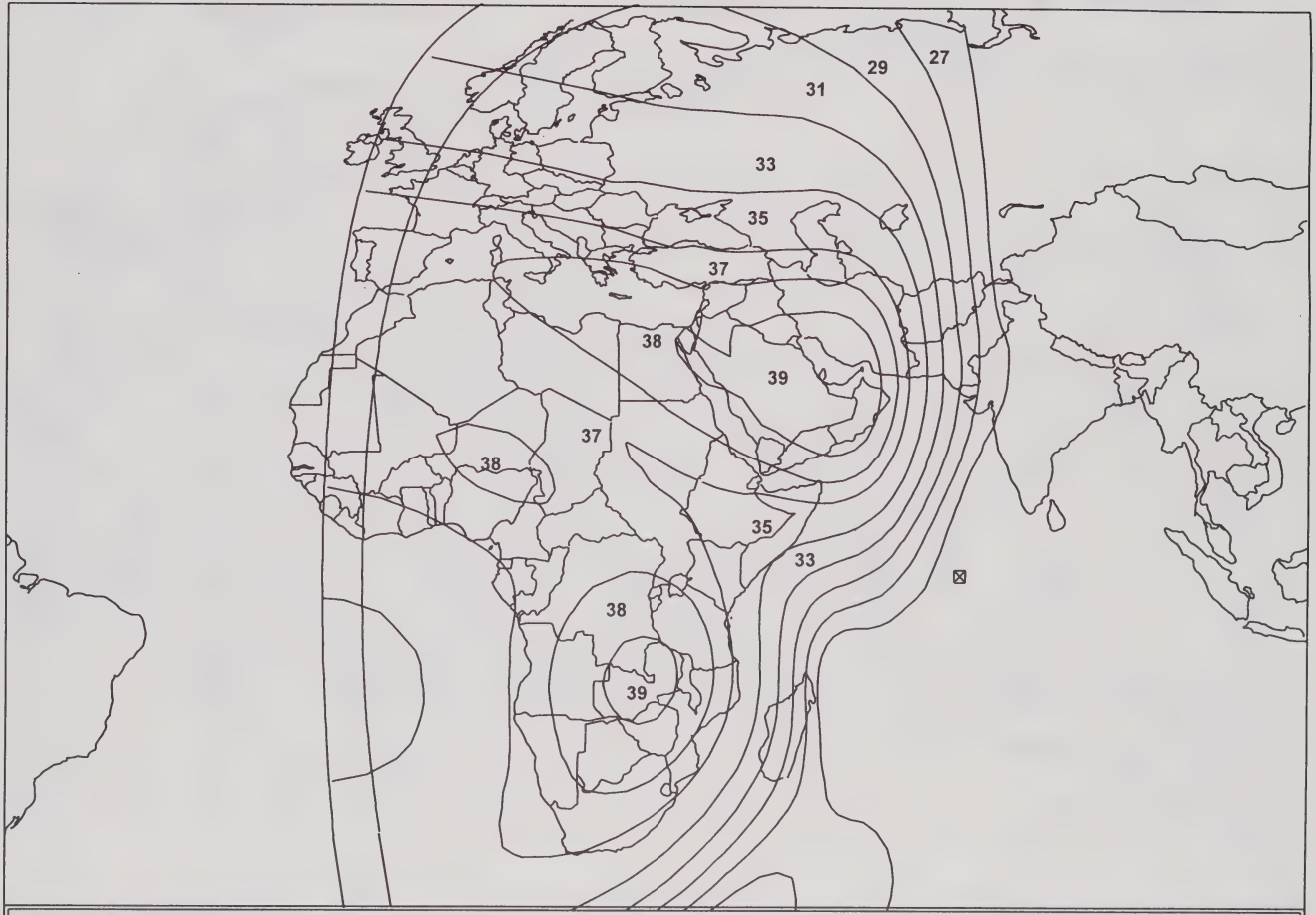
DOWNLINK TRANSMIT

PanAmSat

PAS-4 (IOR) Ku-Band Interconnection Matrix

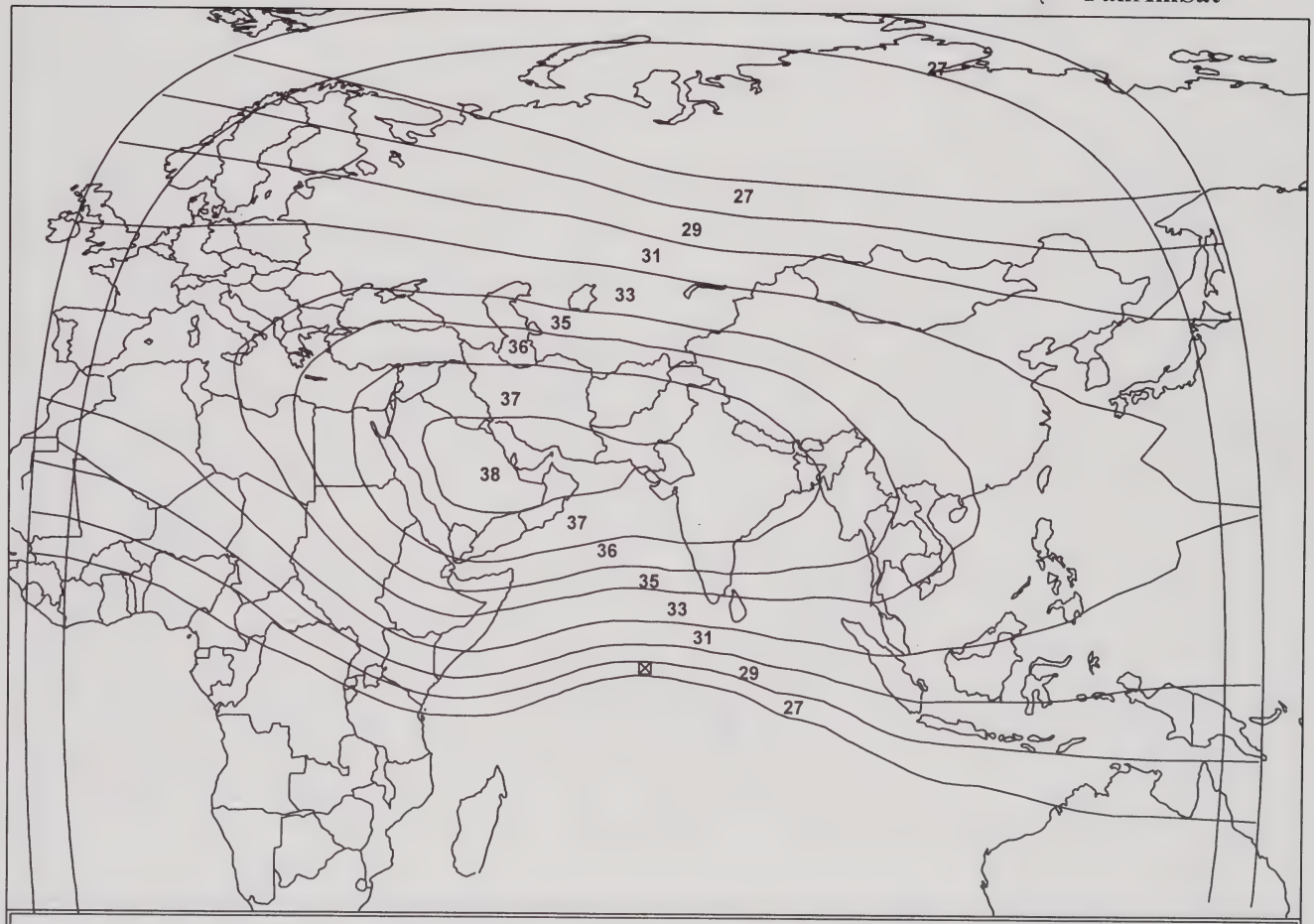
Downlink			Uplink			
Channel	Pol	Coverage	C-Band Vert India/Asia/Aust	C-Band Vert Africa/Eur	Ku-Band Vert Eur/S. Afr./Asia	Ku-Band Horiz Eur/ME/India
1-K	H	S. Africa			1-K	
2-K	H	S. Africa			2-K	
3-K	H	S. Africa			3-K	
4-K	H	S. Africa			4-K	
5-K	V	S.A. or Eur/Rus	2-C		5-K	
6-K	V	S.A. or Eur/Rus	4-C		6-K	
7-K	V	S.A. or Eur/Rus	6-C		7-K	
8-K	V	S.A. or Eur/Rus	8-C		8-K	
9-K*	V	India				9-K
11-K*	V	India				11-K
13-K*	V	India				13-K
15-K*	V	India				15-K
10-K*	H	India				10-K
12-K*	H	India				12-K
14-K*	H	India				14-K
16-K*	H	India				16-K
17-K*	V or H	Eur/Rus or ME				17-K
19-K*	V or H	Eur/Rus or ME				19-K
21-K*	V or H	Eur/Rus or ME				21-K
23-K*	V or H	Eur/Rus or ME				23-K
18-K*	H	India or NE Asia				18-K
20-K*	H	India or NE Asia				20-K
22-K*	H	India or NE Asia				22-K
24-K*	H	India or NE Asia				24-K

*27 MHz Transponders

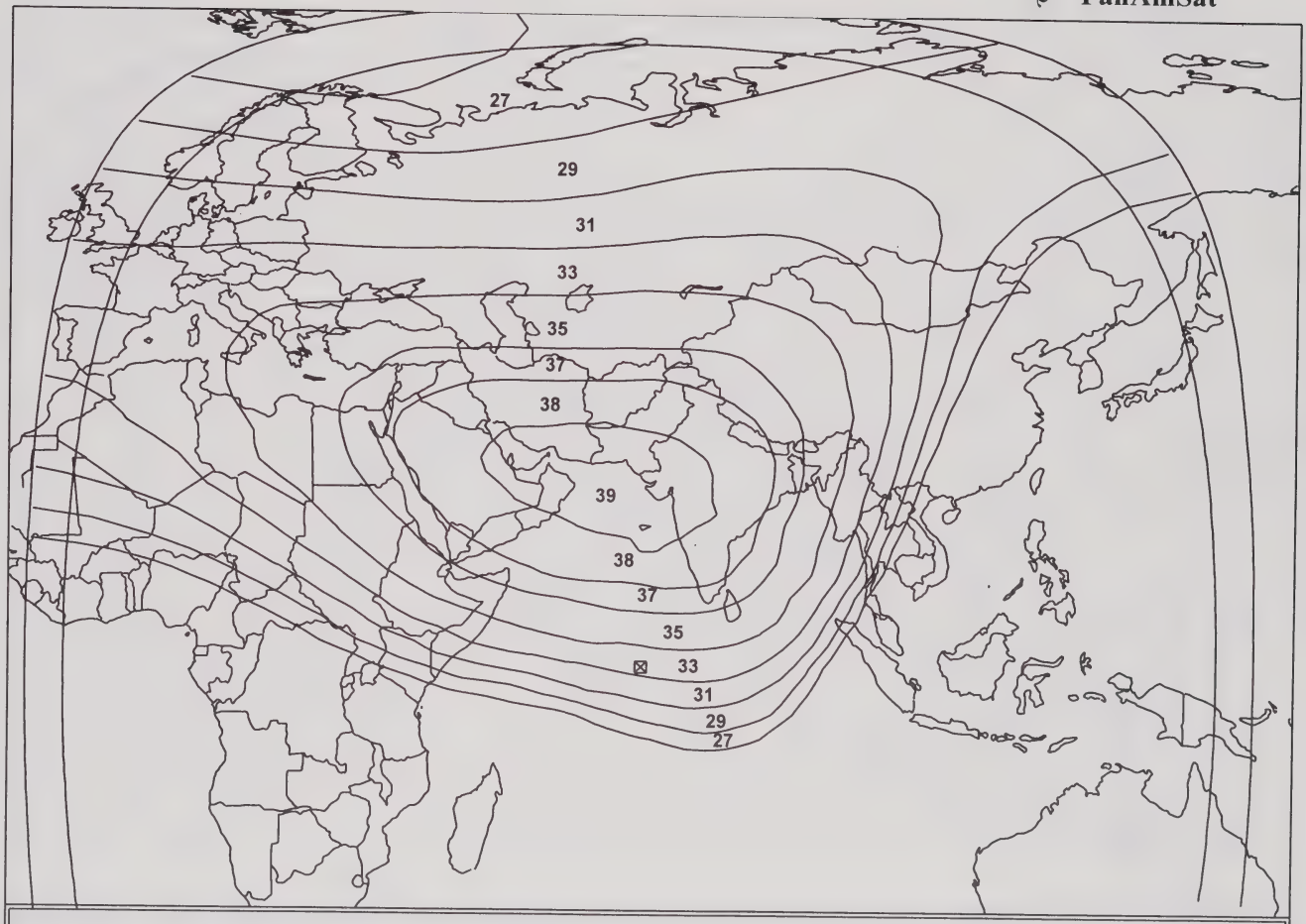


PAS-4 Africa Beam V C-Band

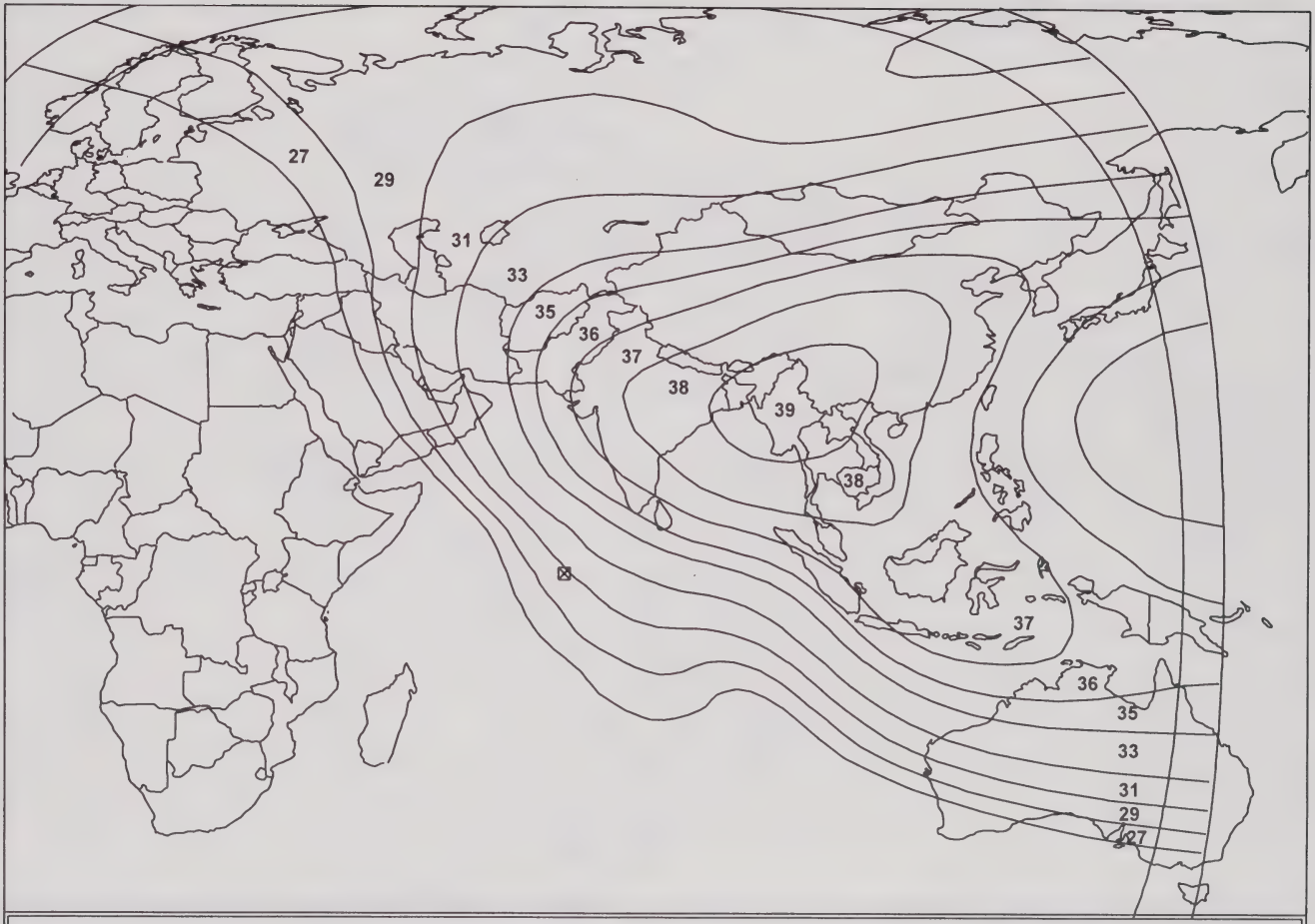
(CONTOURS: 39, 38, 37, 35, 33, 31, 29, 27 dBW)



PAS-4 South Asia/Middle East Horizontal Beam C-Band
(CONTOURS: 38, 37, 36, 35, 33, 31, 29, 27 dBW)

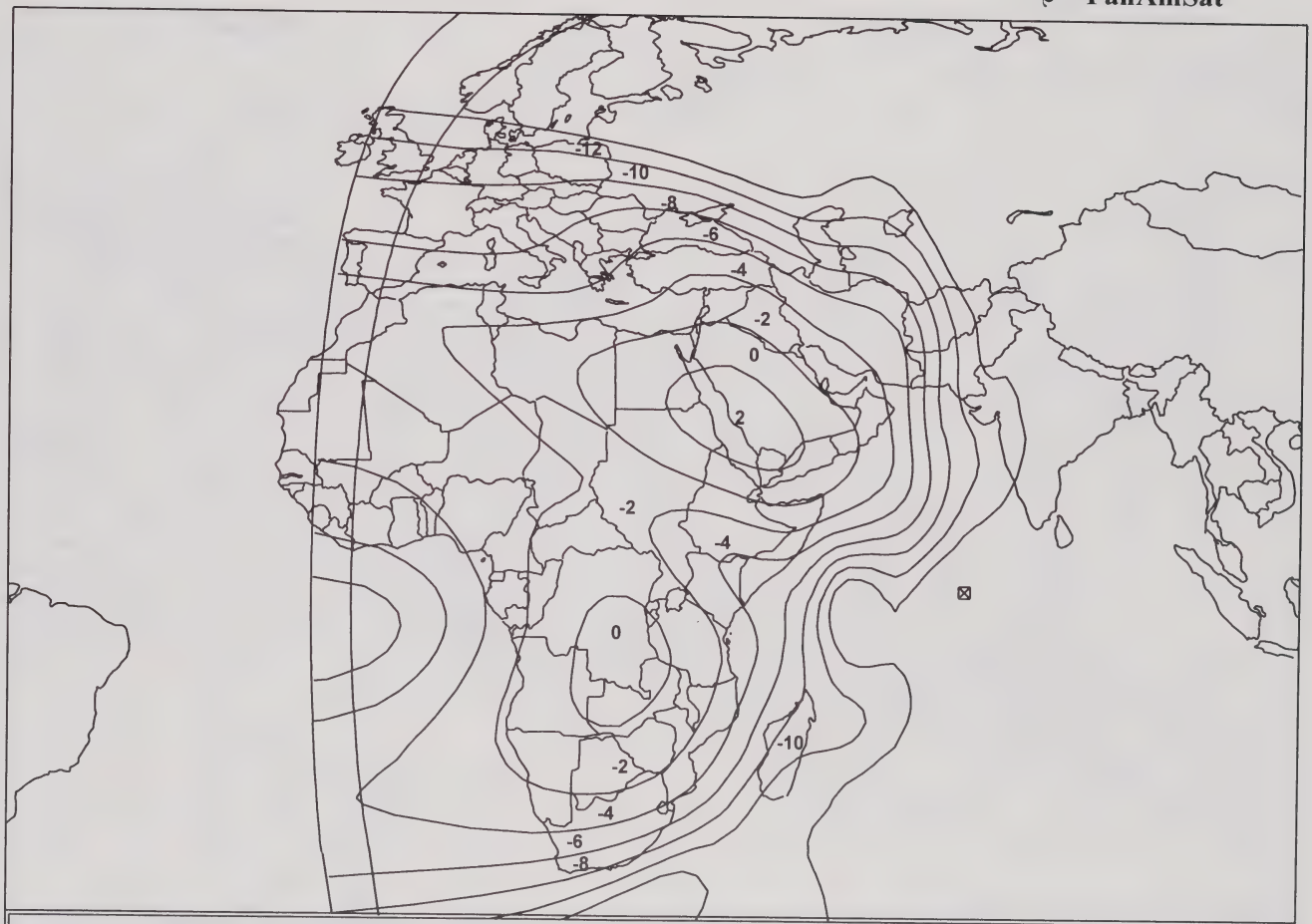


PAS-4 South Asia/Middle East Vertical Beam C-Band
(CONTOURS: 39, 38, 37, 35, 33, 31, 29, 27 dBW)



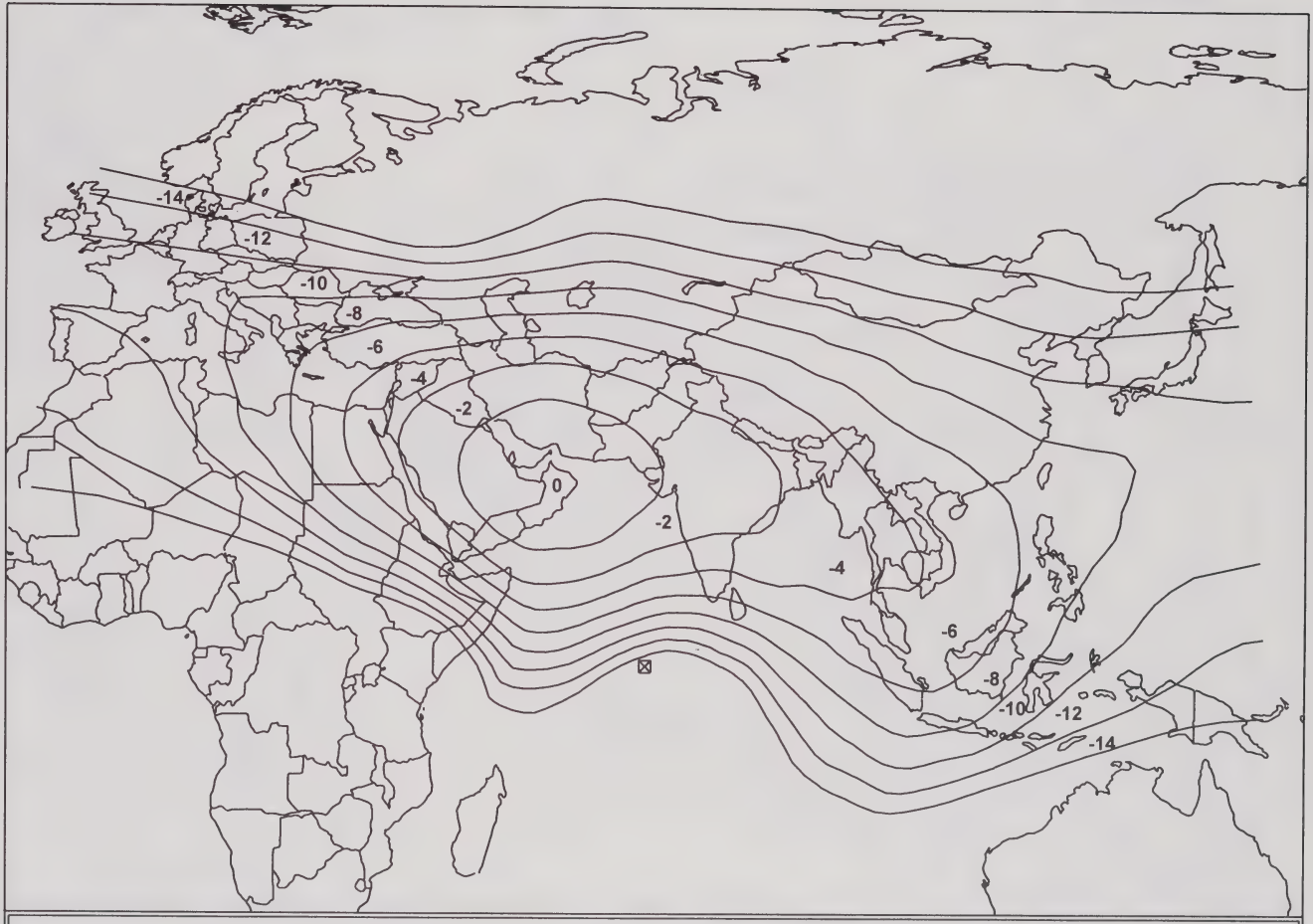
PAS-4 Asia Beam V C-Band

(CONTOURS: 39, 38, 37, 36, 35, 33, 31, 29, 27 dBW)



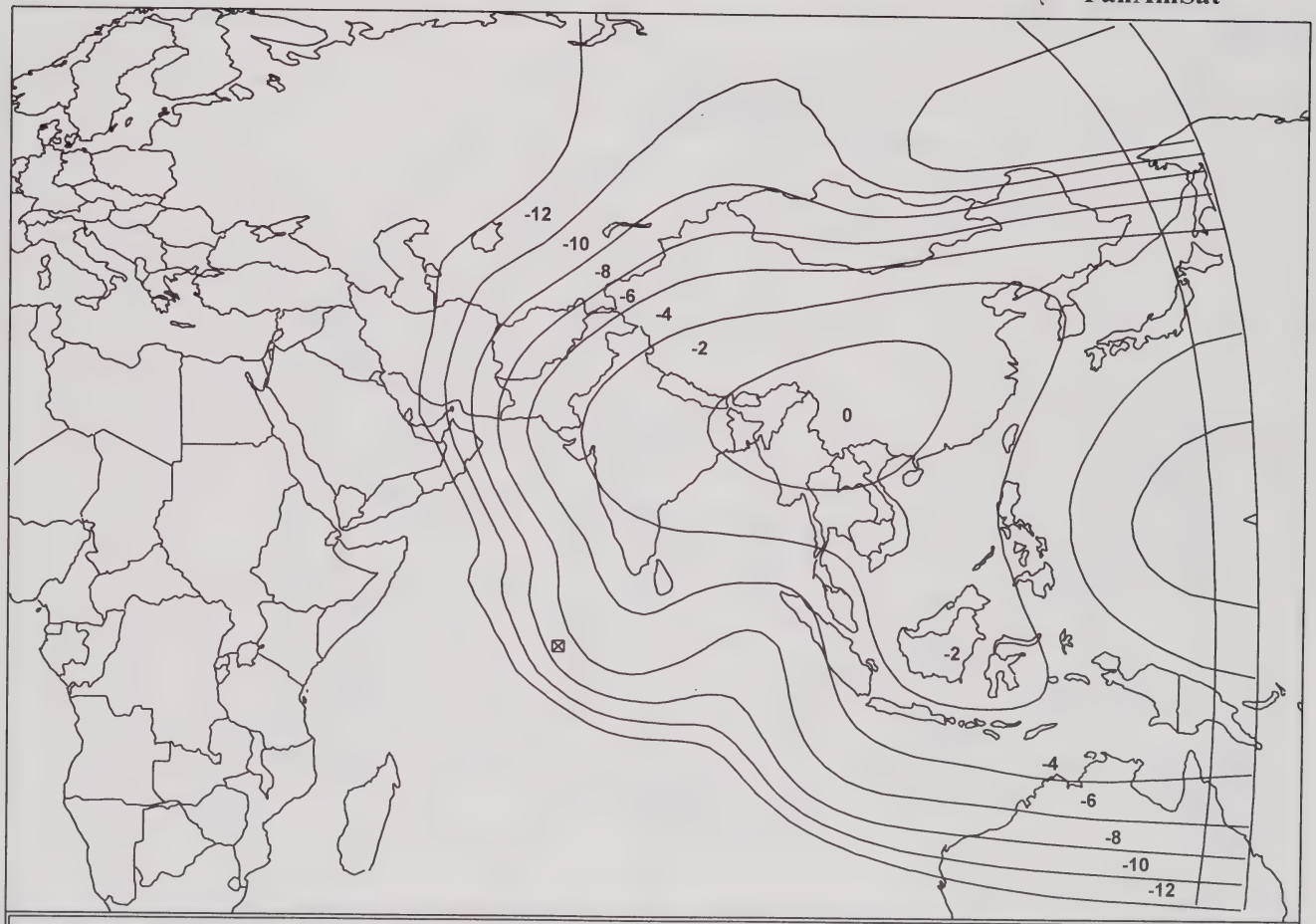
PAS-4 Africa Vertical Uplink Beam C-Band

(CONTOURS: 2, 0,-2,-4,-6,-8,-10,-12 dB/K)

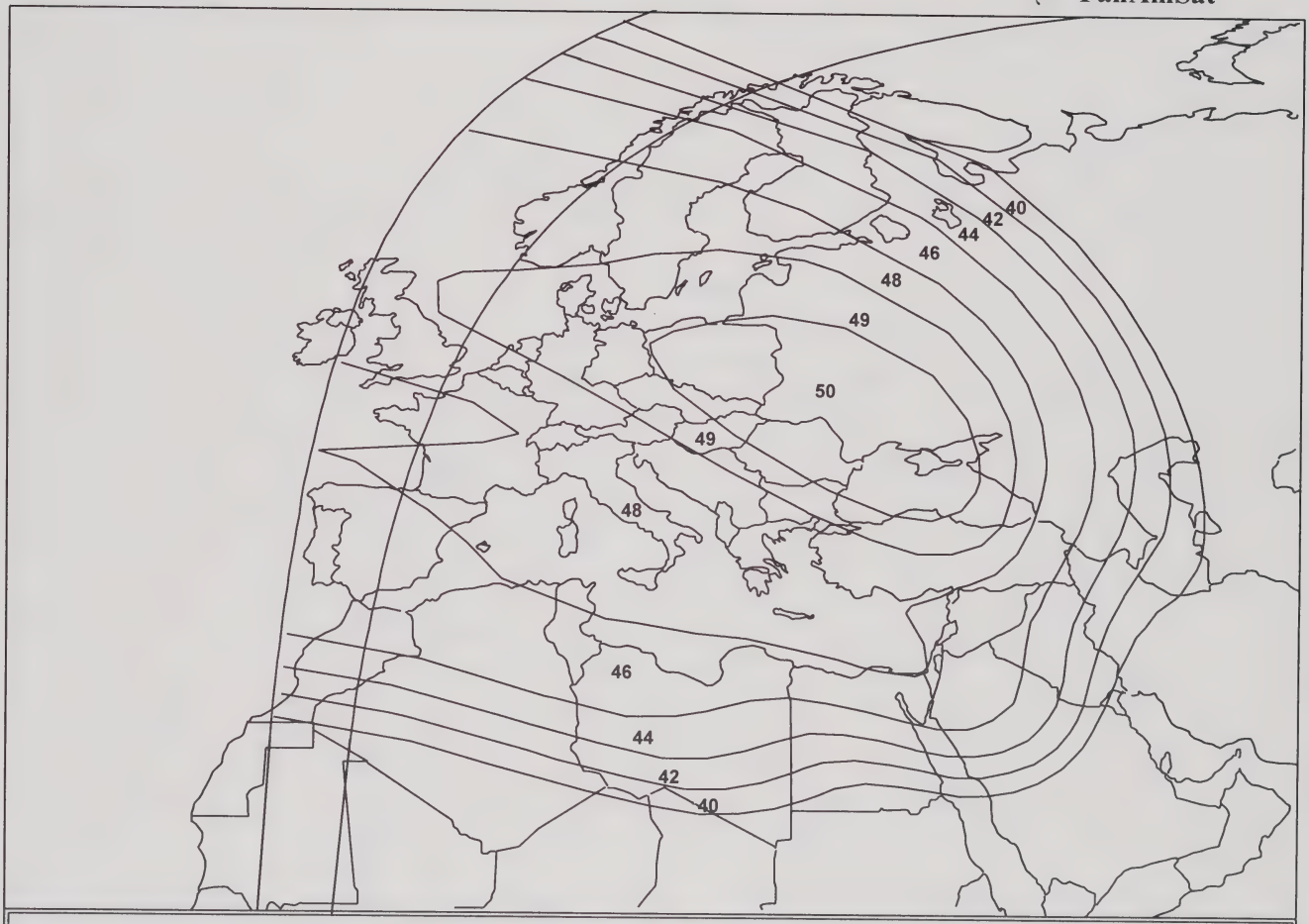


PAS-4 South Asia/Middle East Horiz. Uplink Beam C-Band

(CONTOURS: 0,-2,-4,-6,-8,-10,-12,-14 dB/K)

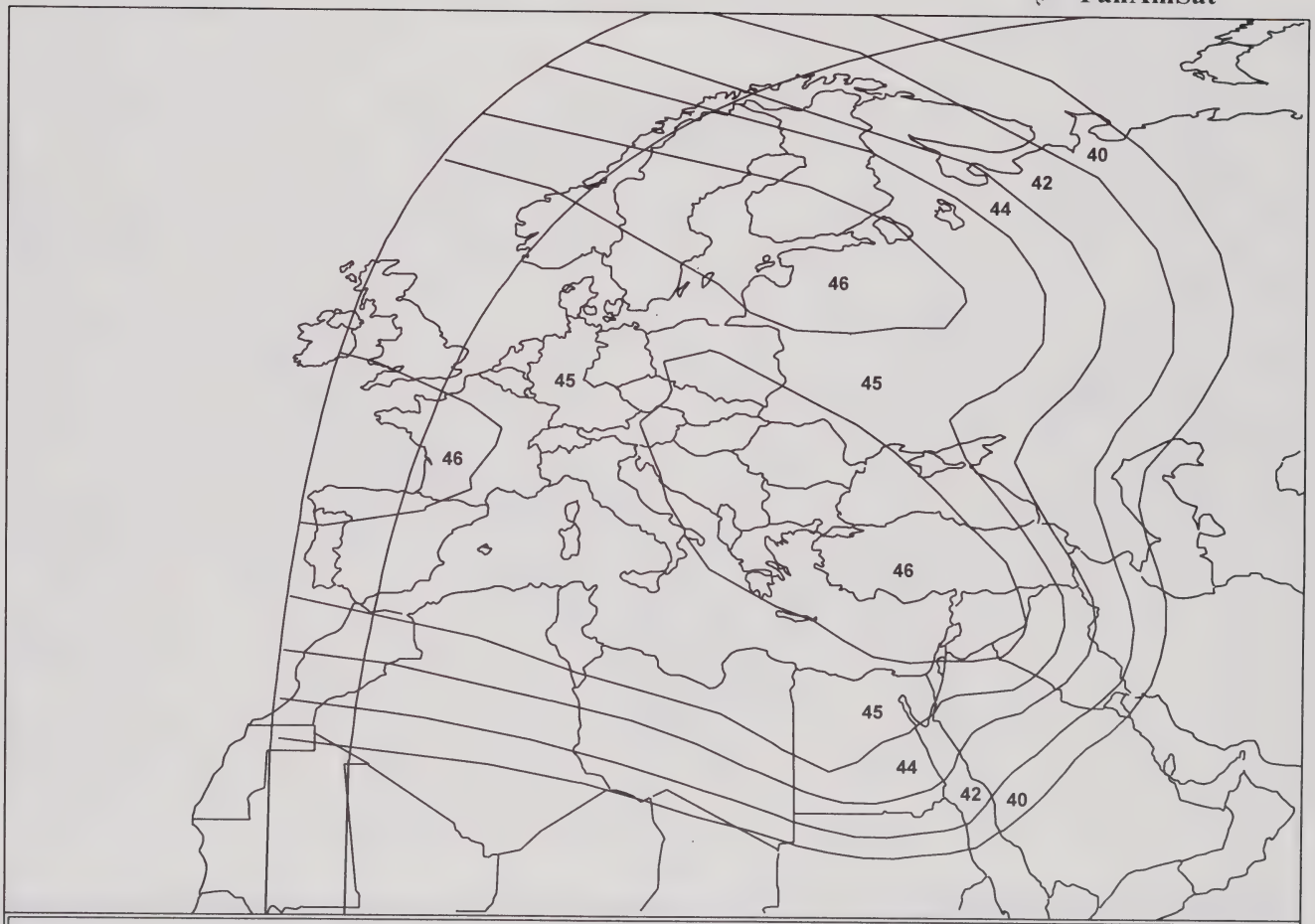


PAS-4 India/Asia/Australia Vertical Uplink Beam C-Band
(CONTOURS: 0,-2,-4,-6,-8,-10,-12 dB/K)



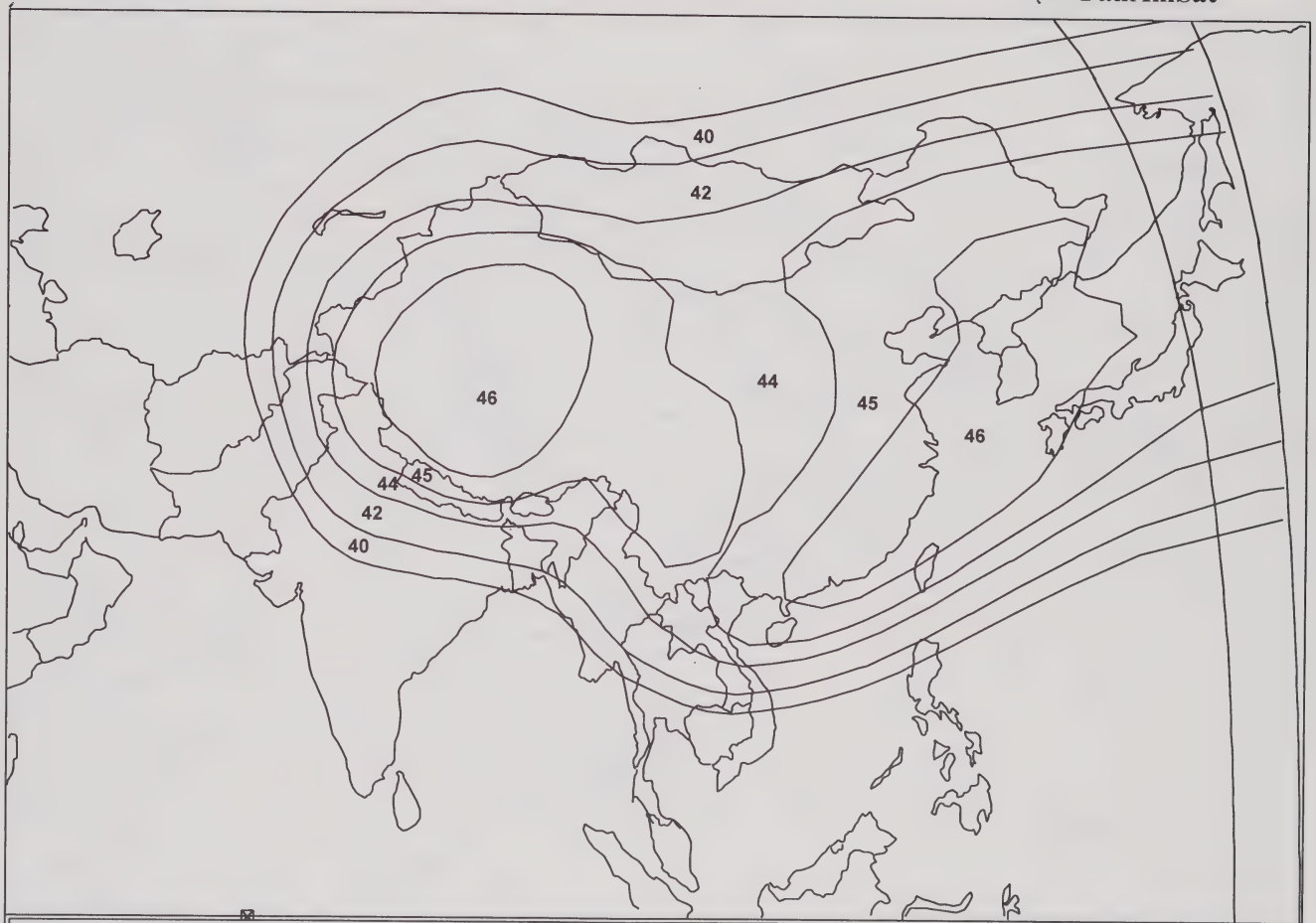
PAS-4 Europe / Russia Beam 1 V Ku-Band

(CONTOURS: 50, 49, 48, 46, 44, 42, 40 dBW)



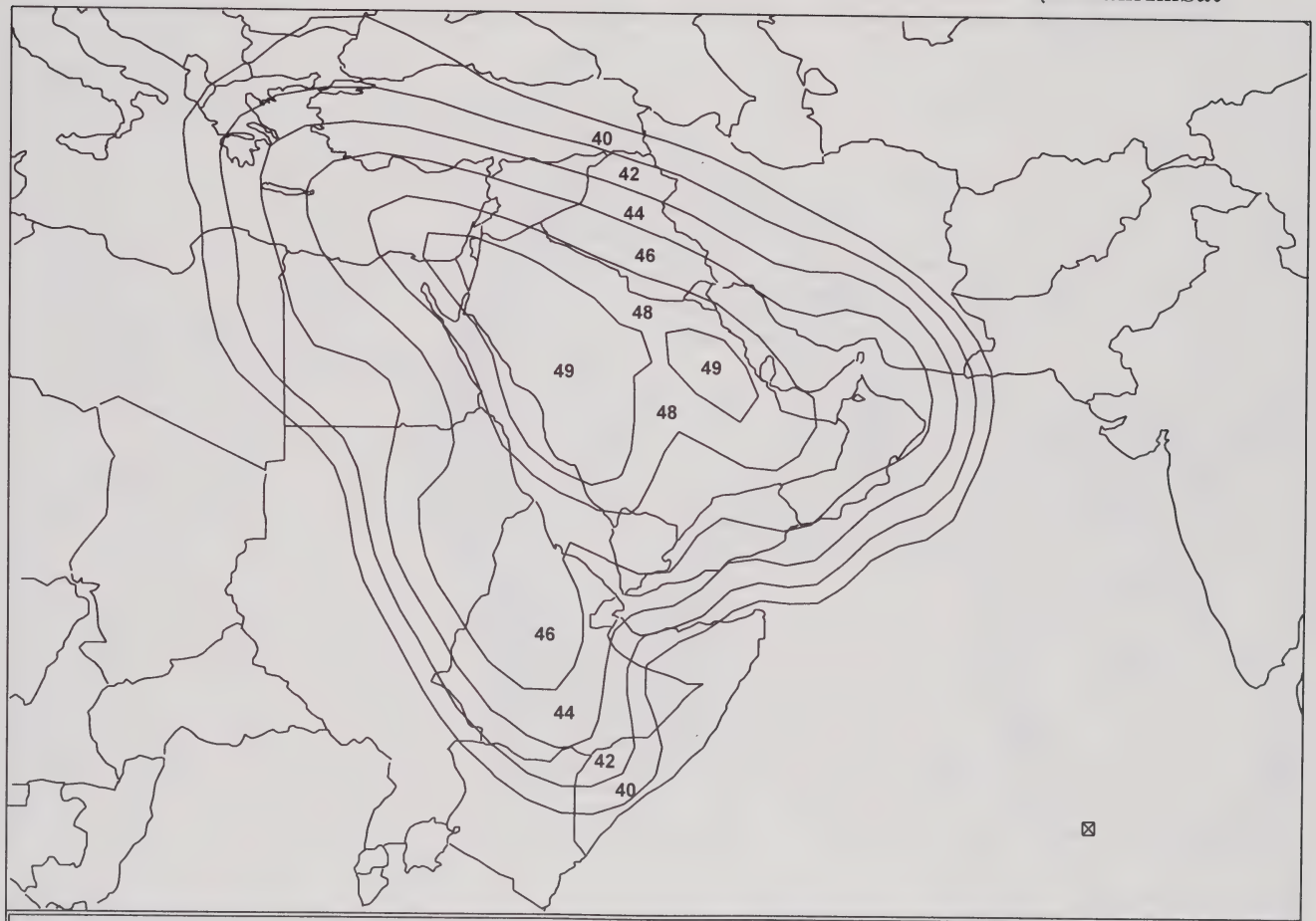
PAS-4 Europe / Russia Beam 2 V Ku-Band

(CONTOURS: 46, 45, 44, 42, 40 dBW)



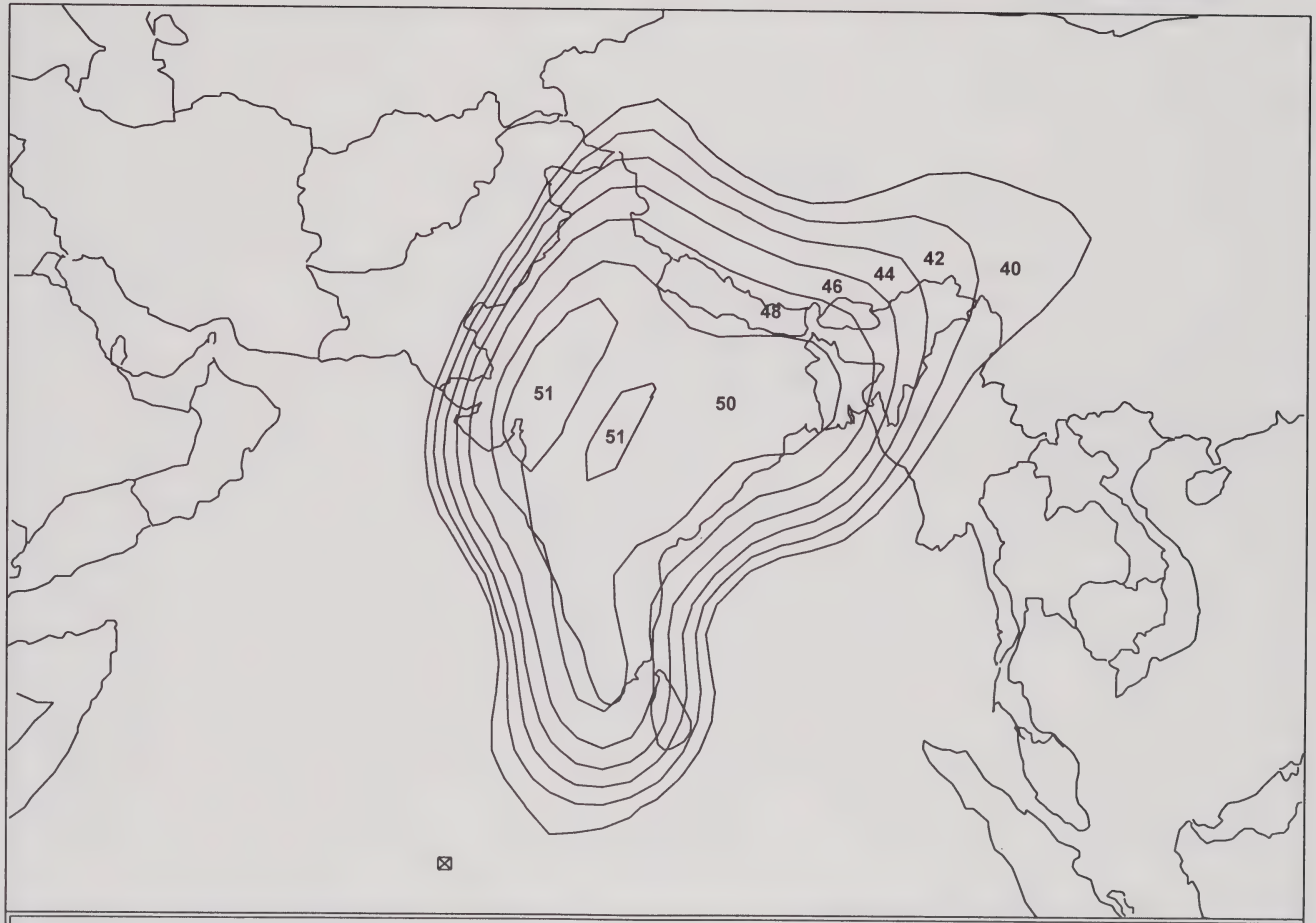
PAS-4 Northeast Asia Beam H Ku-Band

(CONTOURS: 46, 45, 44, 42, 40 dBW)

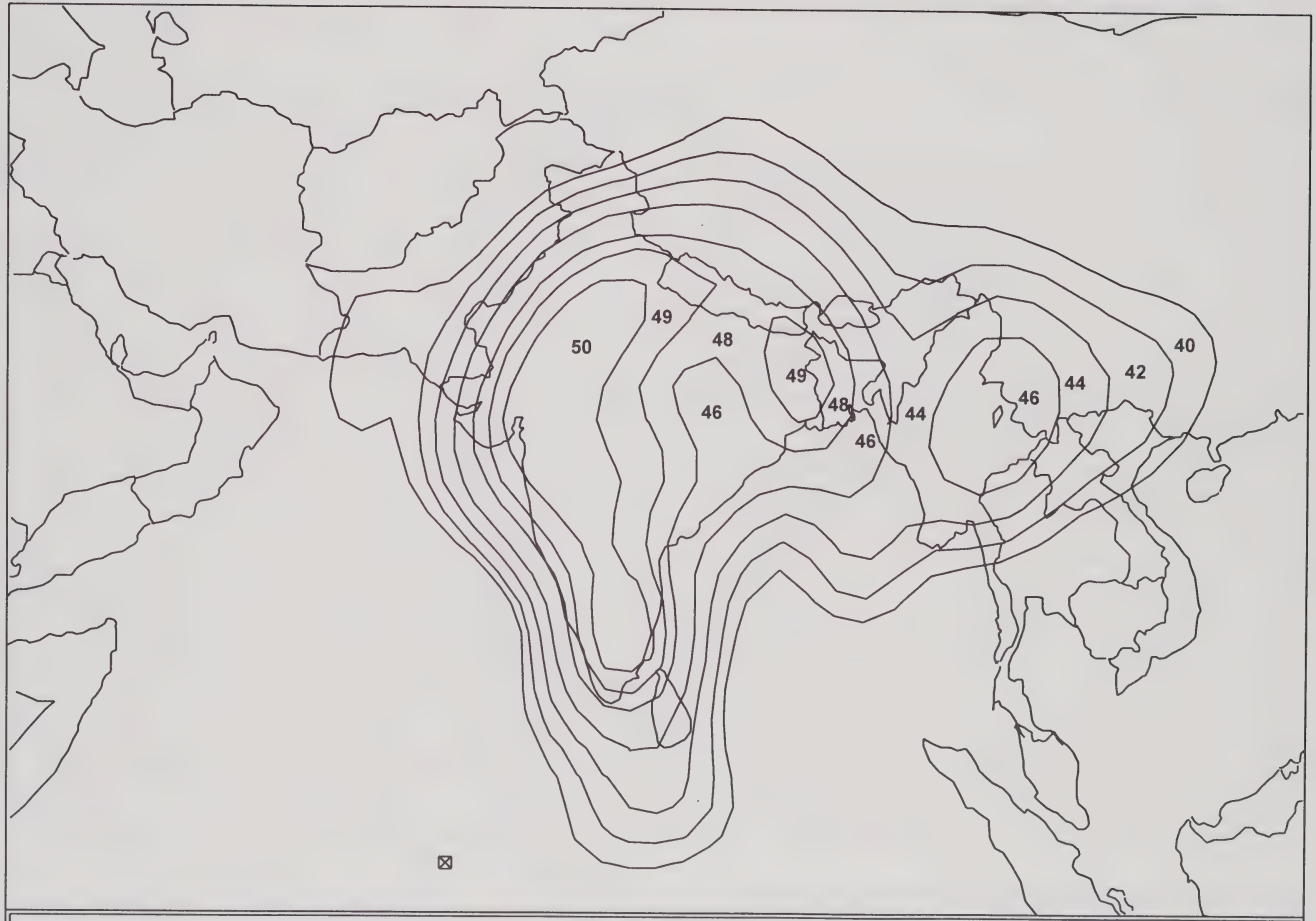


PAS-4 Middle East Beam H Ku-Band

(CONTOURS: 49, 48, 46, 44, 42, 40 dBW)

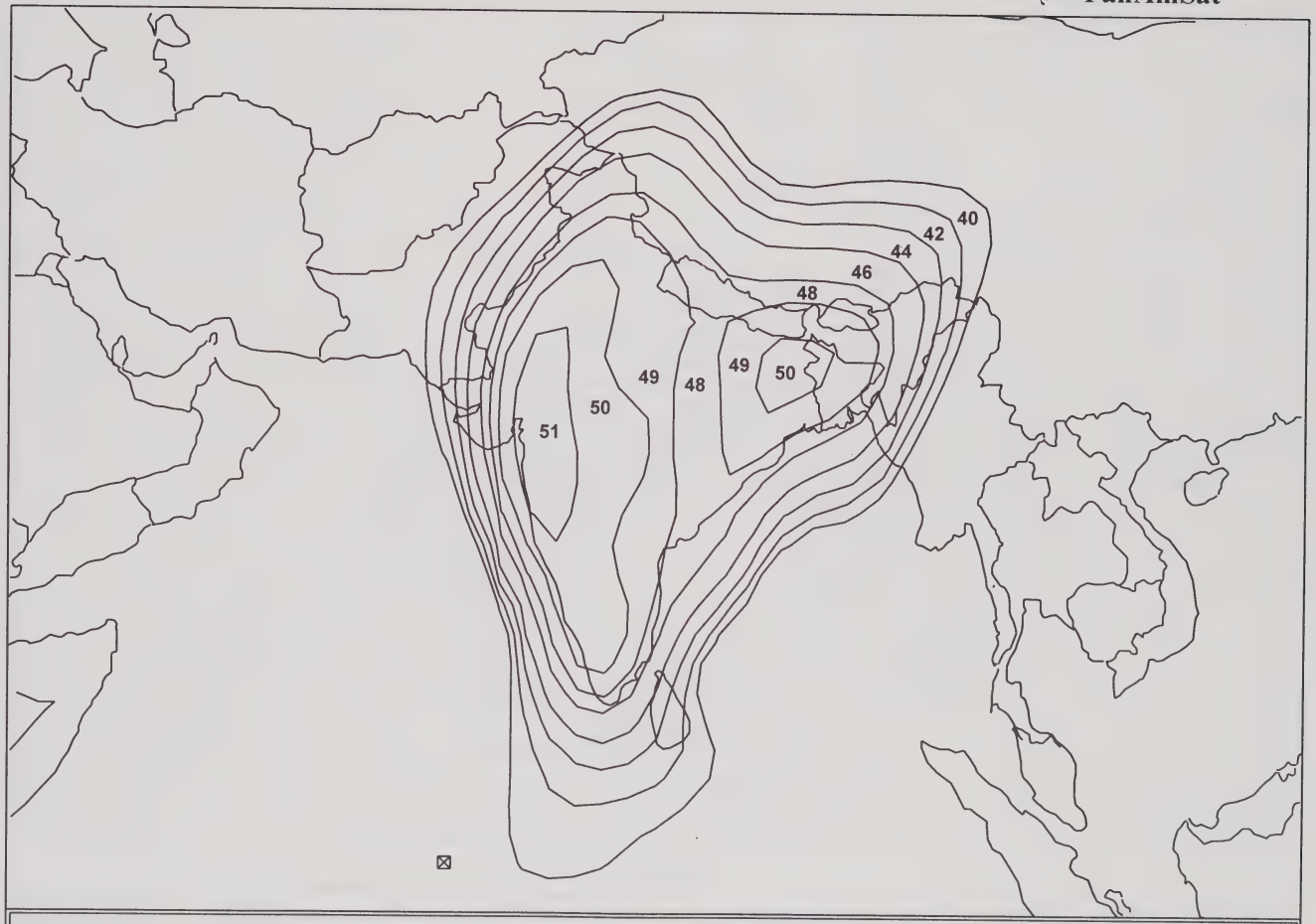


PAS-4 India Horizontal Beam 1 Ku-Band
(CONTOURS: 51, 50, 48, 46, 44, 42, 40 dBW)



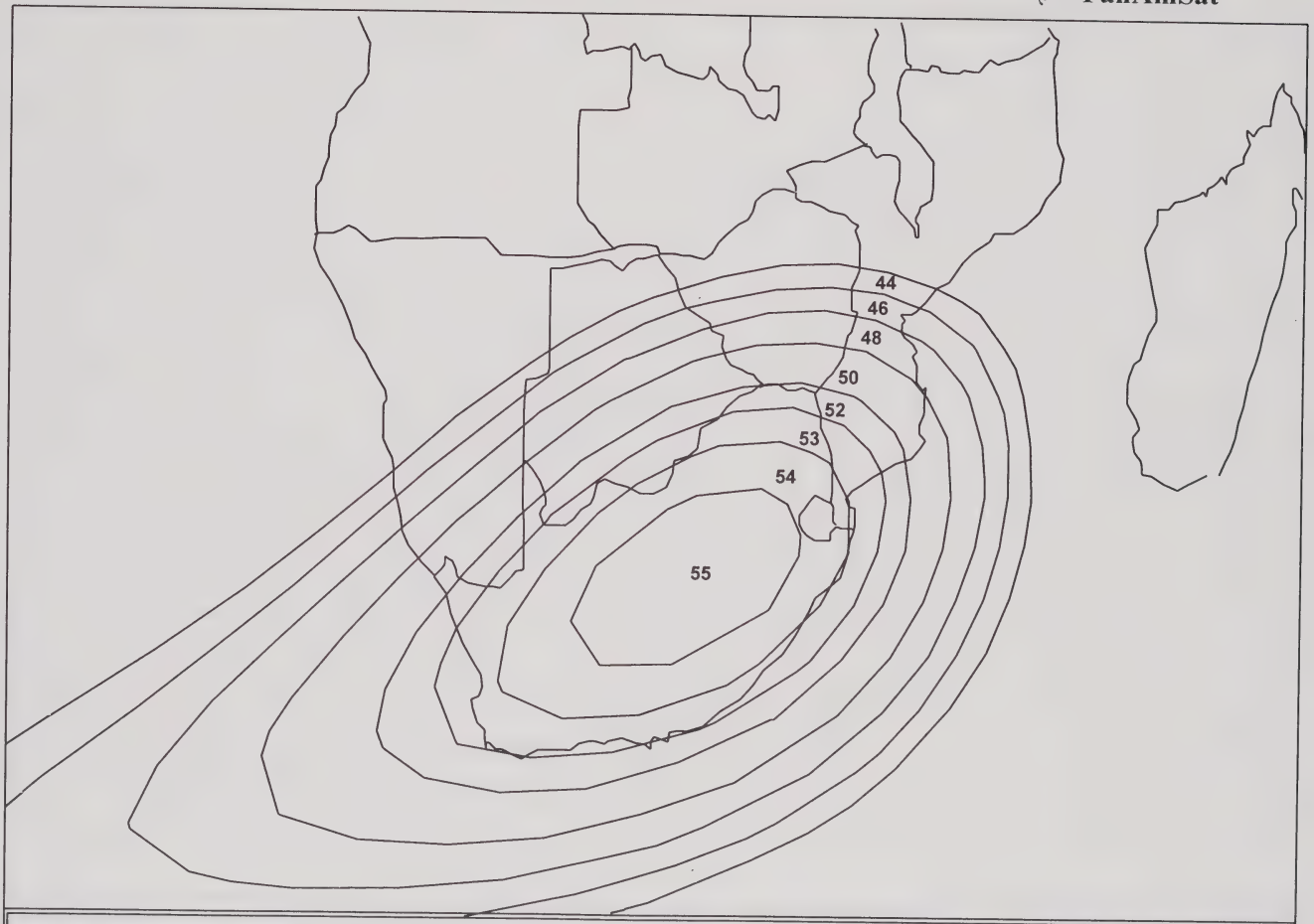
PAS-4 India Horizontal Beam 2 Ku-Band

(CONTOURS: 50, 49, 48, 46, 44, 42, 40 dBW)



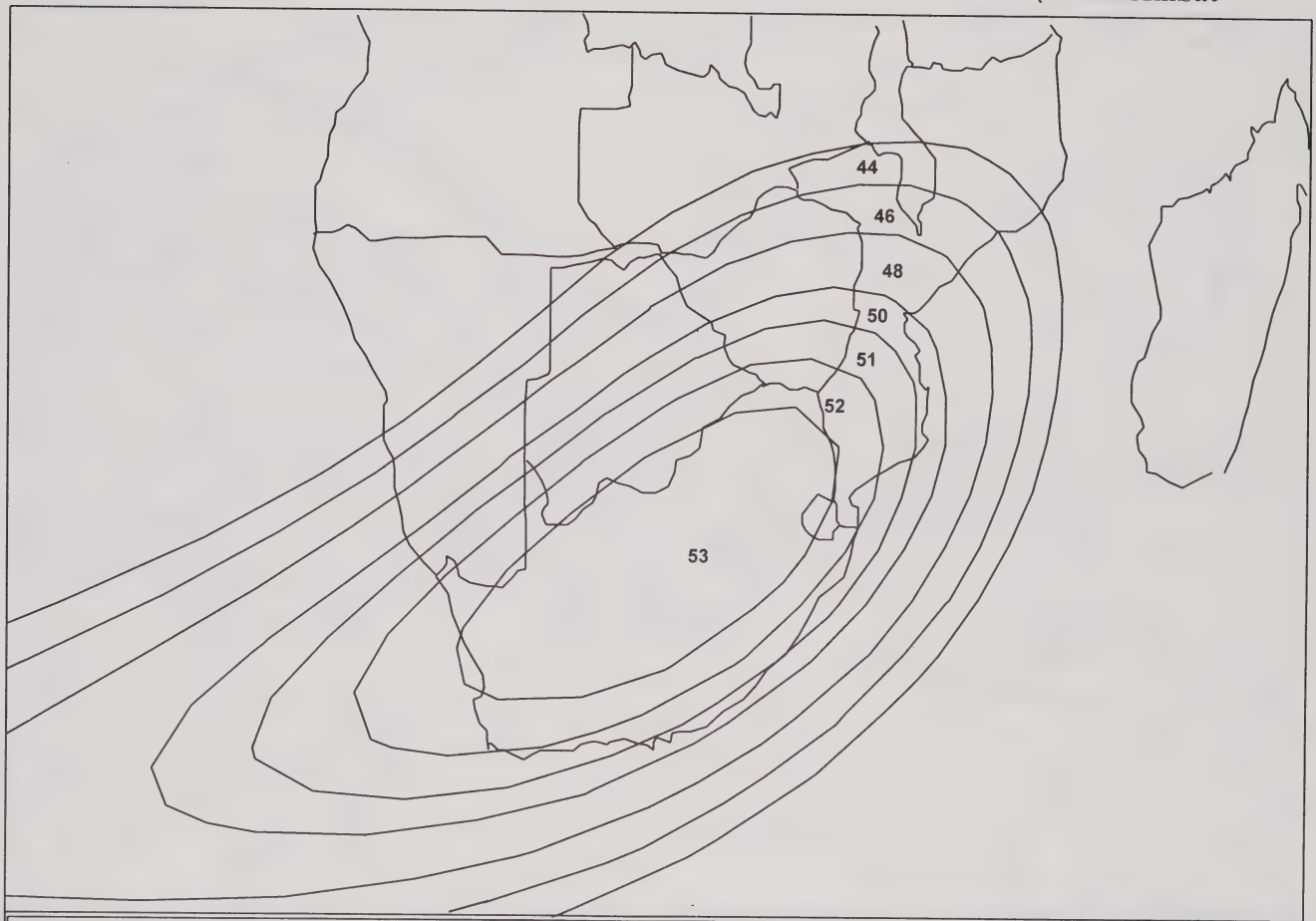
PAS-4 India Vertical Beam Ku-Band

(CONTOURS: 51, 50, 49, 48, 46, 44, 42, 40 dBW)



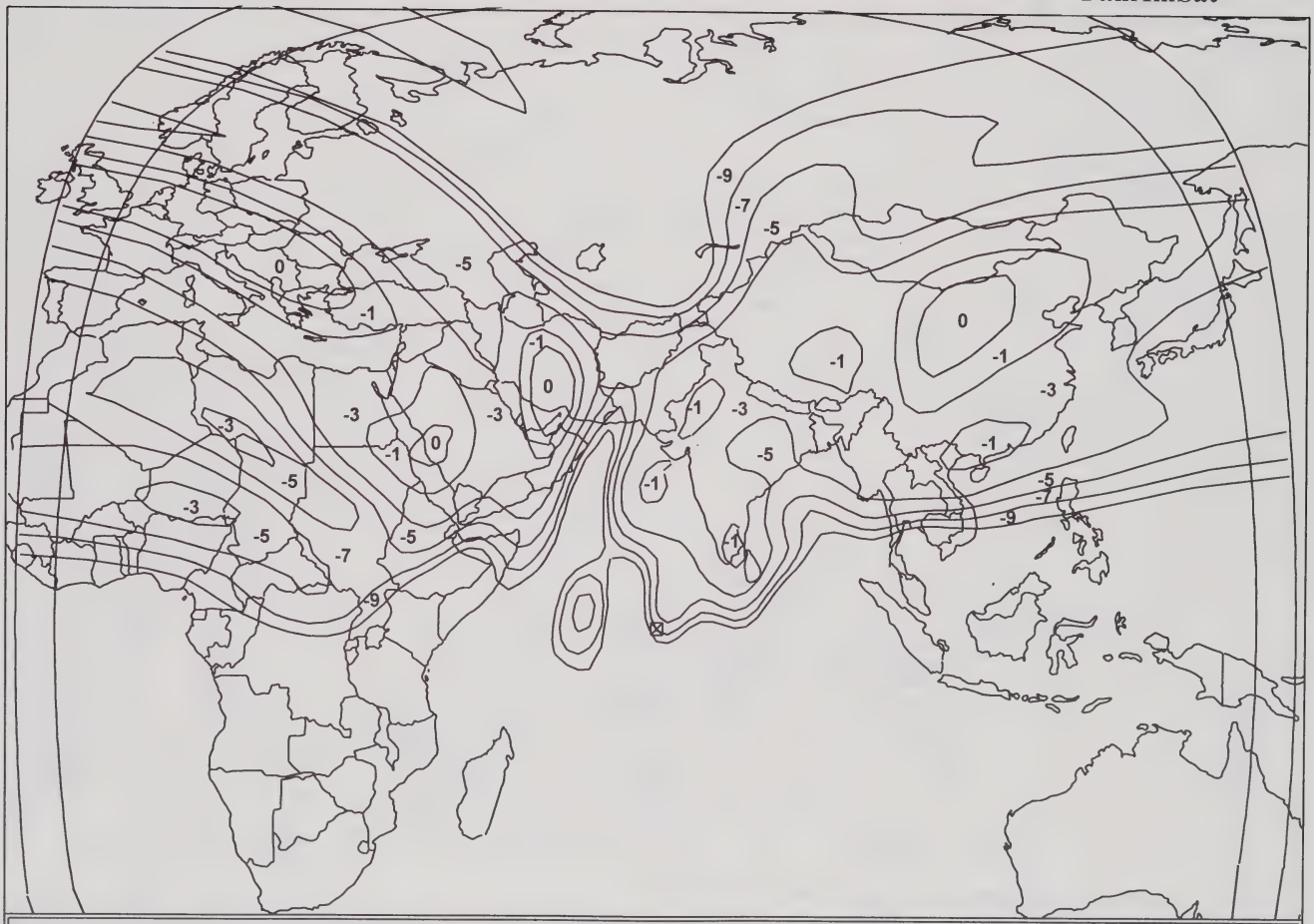
PAS-4 Southern Africa Horizontal Beam Ku-Band

(CONTOURS: 55, 54, 53, 52, 50, 48, 46, 44 dBW)



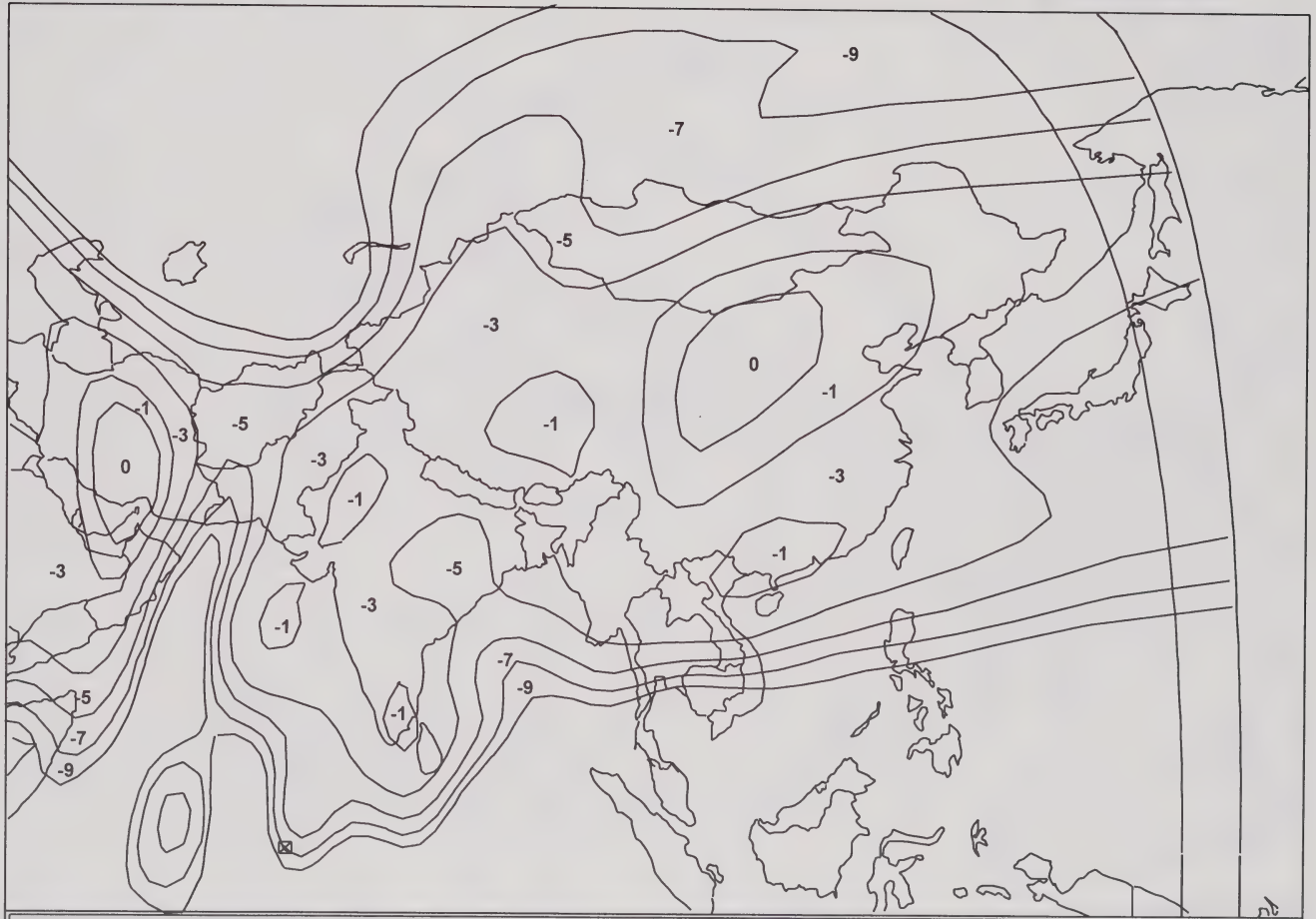
PAS-4 Southern Africa Vertical Beam Ku-Band

(CONTOURS: 53, 52, 51, 50, 48, 46, 44 dBW)



PAS-4 Eur./Middle East/India/Asia Horiz. Uplink Beam Ku-Band

(CONTOURS: 0,-1,-3,-5,-7,-9 dB/K)

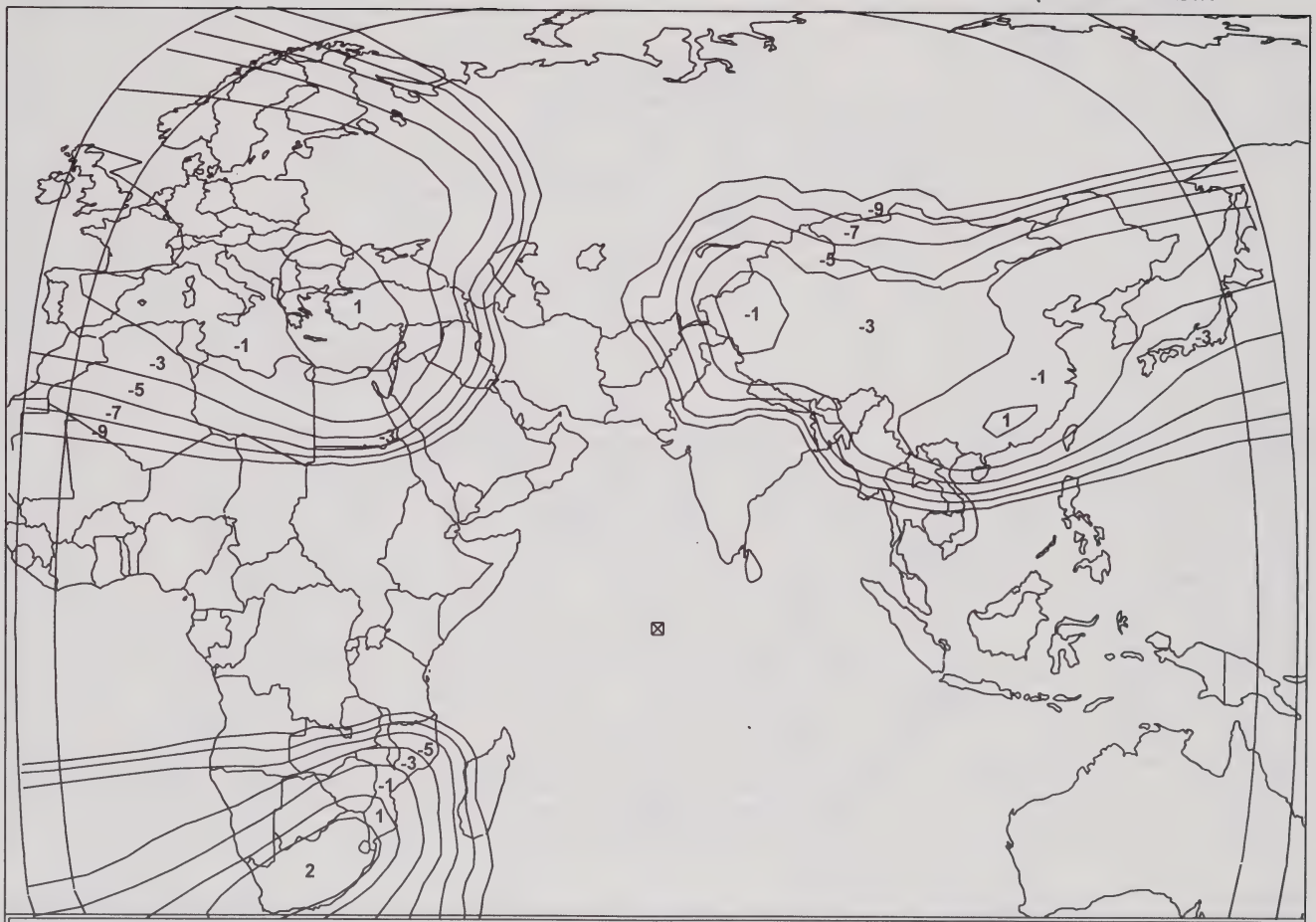


PAS-4 Eur./Middle East/India/Asia Horiz. Uplink Beam Ku-Band

(CONTOURS: 0,-1,-3,-5,-7,-9 dB/K)

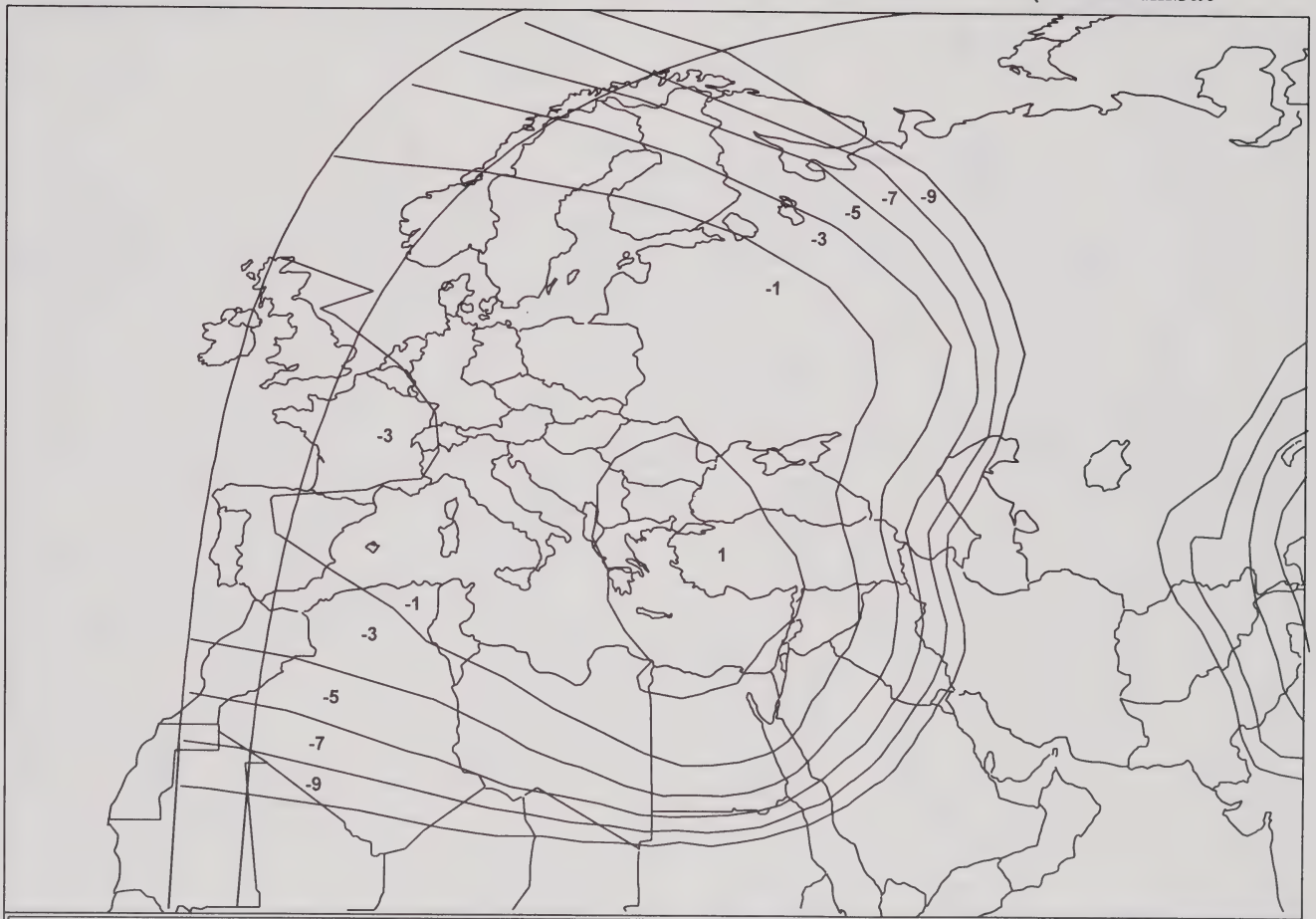
PAS-4 Eur./Middle East/India/Asia Horiz. Uplink Beam Ku-Band

(CONTOURS: 0,-1,-3,-5,-7,-9 dB/K)



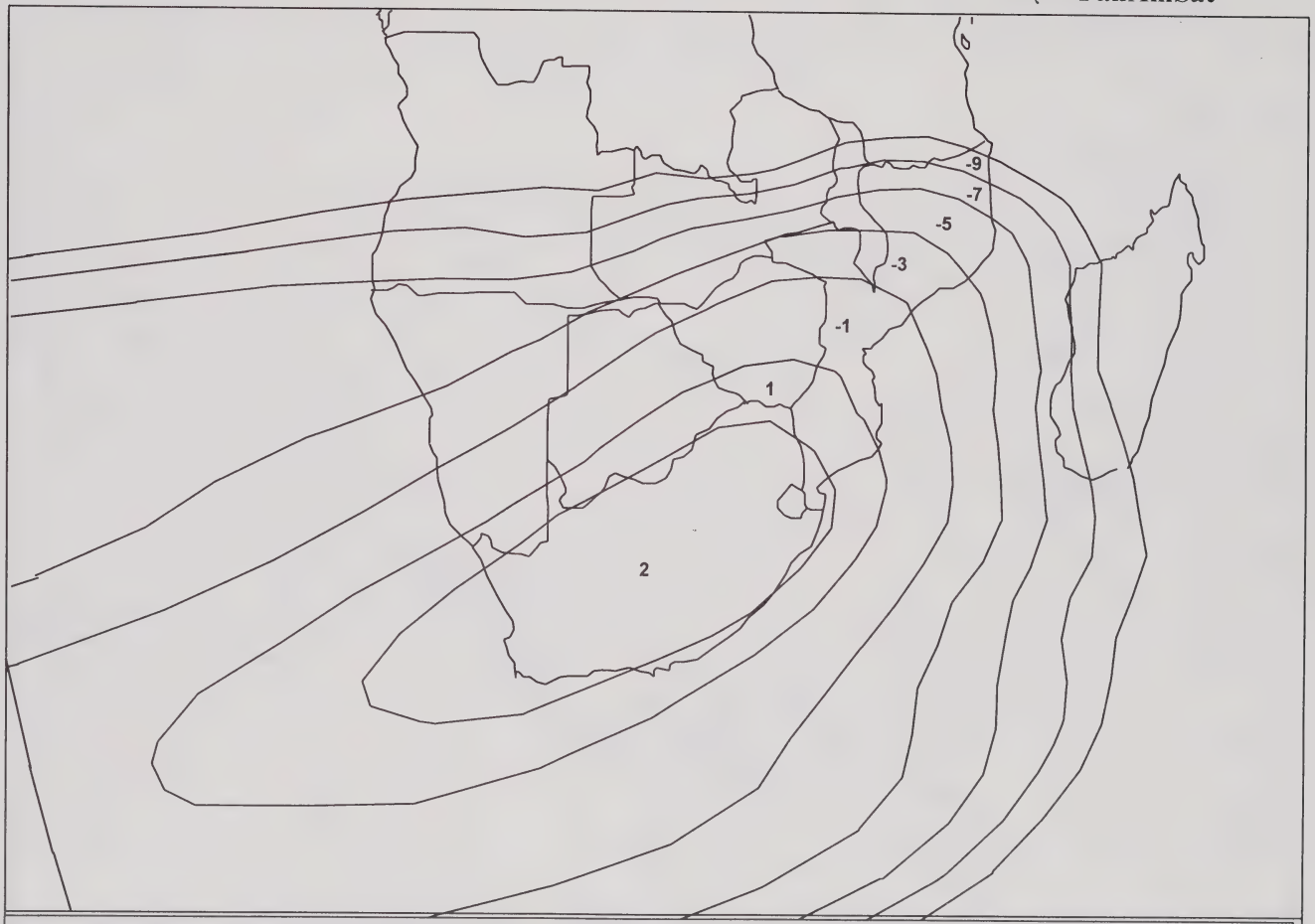
PAS-4 Eur. / So. Africa / Asia Vertical Uplink Beam Ku-Band

(CONTOURS: 2, 1,-1,-3,-5,-7,-9 dB/K)



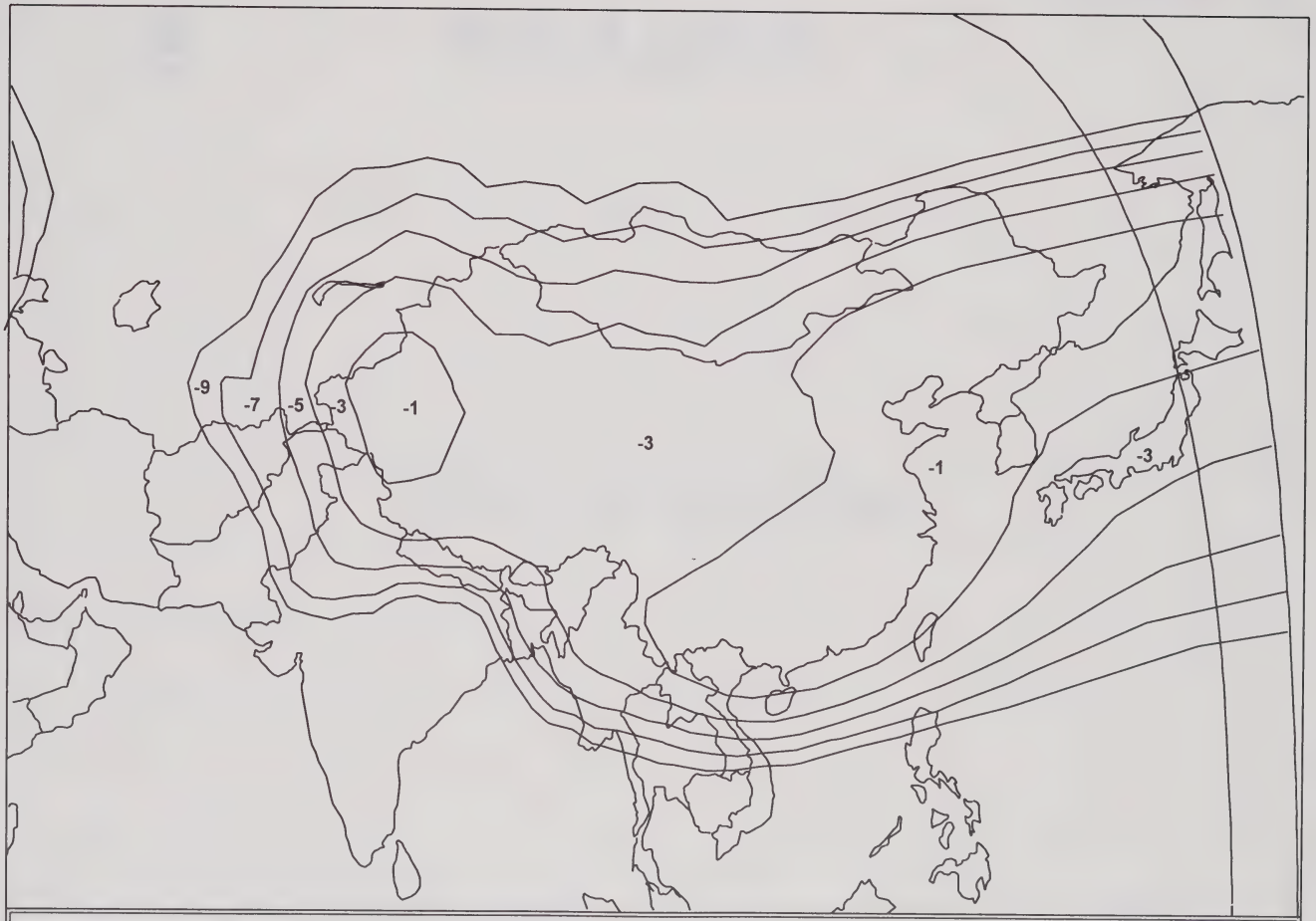
PAS-4 Eur. / So. Africa / Asia Vertical Uplink Beam Ku-Beam

(CONTOURS: 1,-1,-3,-5,-7,-9 dB/K)



PAS-4 Eur. / So. Africa / Asia Vertical Uplink Beam Ku-Beam

(CONTOURS: 2, 1,-1,-3,-5,-7,-9 dB/K)



PAS-4 Eur. / So. Africa / Asia Vertical Uplink Beam Ku-Band

(CONTOURS:-1,-3,-5,-7,-9 dB/K)

Video Link Information

Typical Analog Video Carrier Parameters

	Single Channel	Dual Channel
Allocated RF Bandwidth:	54 MHz	27 MHz
Occupied RF Bandwidth:	30 MHz	24 MHz
Deviation (1 V peak):	10.75 MHz	10.75 MHz
Video Bandwidth (NTSC):	4.2 MHz	4.2 MHz
Audio Subcarrier Frequencies:	6.2/6.8 MHz	6.2/6.8 MHz

Notes: 1) PAL, SECAM, and other modulation characteristics are compatible provided that allocated RF bandwidths are not exceeded.
2) Subcarrier configurations may be determined by the customer.
3) Overdeviation permitted provided that RF roofing filters are employed.

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Typical Analog Video Link Specifications
(Single Channel Configuration)

	Service Type		
	Broadcast	**Cable**	**Home**
Minimum S/N (Weighted):	50 dB	47 dB	43 dB
Minimum C/N:	13.0 dB	10.0 dB	7.0 dB
Desired Link Availability:	>99.9 %	>99.5%	>99.0%
Minimum Link Margin (Clear Sky):	1.5 dB	1.5 dB	1.5 dB

Notes: 1) Antenna sizes must be adjusted for local rain conditions to meet link availabilities.
2) Minimum S/N based on NTSC 30 MHz video.
3) Minimum C/N based on typical receiver threshold performance.

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Typical Digital Video Carrier Parameters

	Single Carrier	Dual Carrier	SCPC Carrier
Allocated RF Bandwidth:	54 MHz	27 MHz	8 MHz
Occupied RF Bandwidth:	36 MHz	24 MHz	6 MHz
Information Rate:	44 Mbps	27 Mbps	6.73 Mbps
Transmission Rate:	59 Mbps	39 Mbps	9.75 Mbps
Code Rate:	3/4	3/4	3/4
Modulation:	QPSK	QPSK	QPSK
Minimum C/N:	7.0 dB	7.0 dB	7.0 dB

Notes: 1) Channelization of digital data stream (i.e. channels per link) may be adjusted for specific picture quality.
2) Transmission rates include concatenated Reed-Solomon encoding.
3) Other transmission systems or configurations may be used which do not exceed allocated bandwidth

Digital Link Information

Typical SCPC Digital Carrier Parameters

Data Rate	Modulation	Code Rate	Occupied Bandwidth	Allocated Bandwidth	Carriers per 64MHz Trans.	C/N Clear Sky	C/N Degraded
64 kbps	QPSK	R1/2	82 kHz	100 kHz	640	6.2 dB	5.3 dB
64 kbps	BPSK	R1/2	164 kHz	200 kHz	320	3.4 dB	2.9 dB
64 kbps	QPSK	R3/4	56 kHz	75 kHz	850	8.8 dB	8.0 dB
512 kbps	QPSK	R1/2	655 kHz	725 kHz	88	6.8 dB	5.7 dB
1.544 Mbps	QPSK	R1/2	1970 kHz	2200 kHz	29	6.8 dB	5.7 dB

Notes:
1) Other data rates modulations, FEC rates and C/N figures are permitted subject to PAS approval.
2) C/N figures above yield a BER>10-8 clear sky and a BER>10-6 degraded.
3) Specific link availabilities may be requsted. Additional margins may be required.
4) Transponder loading based on 64 MHz usable bandwidth and bandwidth limited operation.

Downlink Earth Station Sizing Guides

Downlink Earth Station Sizing Guides

Notes on Use

1) All links based on clear sky and should be used for comparison purposes only. Ku-Band data links include a 2.5/3.5 uplink/downlink rain margins. Specific links should be individually calculated.

2) Standard margin of 1.0 dB applied to all links for all sources (depolarization, satellite pointing and orbit variations); additional downlink margin of 0.5 dB applied for receive antenna pointing error

3) Uplink noise contribution is assumed to be negligible due to G/T and attenuator settings. All downlink path loss is based on an elevation angle of 20°.

4) Earth station G/T is controlling value. Earth station size is based on typical receive gain, feed loss, antenna noise temperature and LNB performance.

PanAmSat

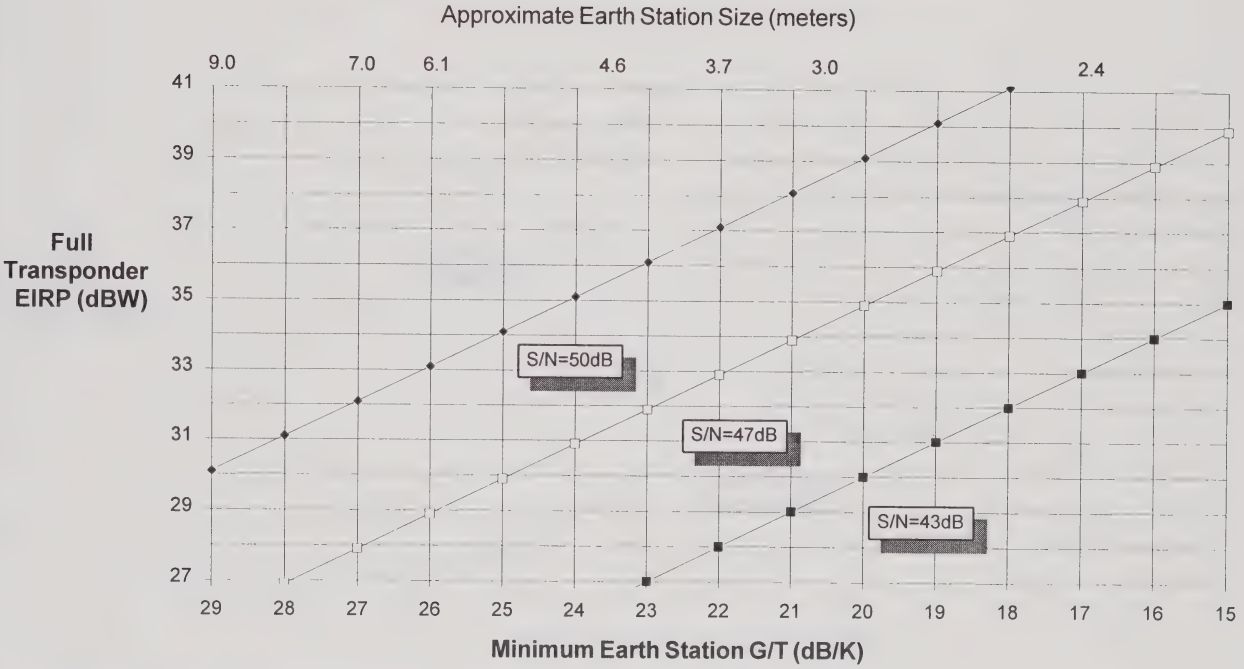
Typical Downlink Earth Station Performance

Terminal Size	Receive Gain	Total Noise	Minimum G/T
1.8m C-Band	35.3	90	14.4
2.4m C-Band	38.1	90	17.4
3.7m C-Band	41.2	90	20.9
4.5m C-Band	43.9	90	23.6
6.1m C-Band	46.5	90	26.2
7.0m C-Band	47.5	90	27.0
9.0m C-Band	50.1	90	29.2
0.9m Ku-Band	39.0	160	16.4
1.2m Ku-Band	41.3	160	18.7
1.8m Ku-Band	44.8	160	22.2
2.4m Ku-Band	47.5	160	24.9
3.7m Ku-Band	51.1	160	28.5
4.6m Ku-Band	53.5	160	30.9
6.1m Ku-Band	55.5	160	33.1

Note: 1) LNA Temperature of 45 deg C-band (analog video), 65 deg C-band (data), 110 deg Ku-band (both) (data shown or C-Band)
2) 0.15 dB feed loss for C-Band < 3.7m, 0.20 dB > 3.7m, all Ku-Band feed loss is 0.25 dB.

PanAmSat

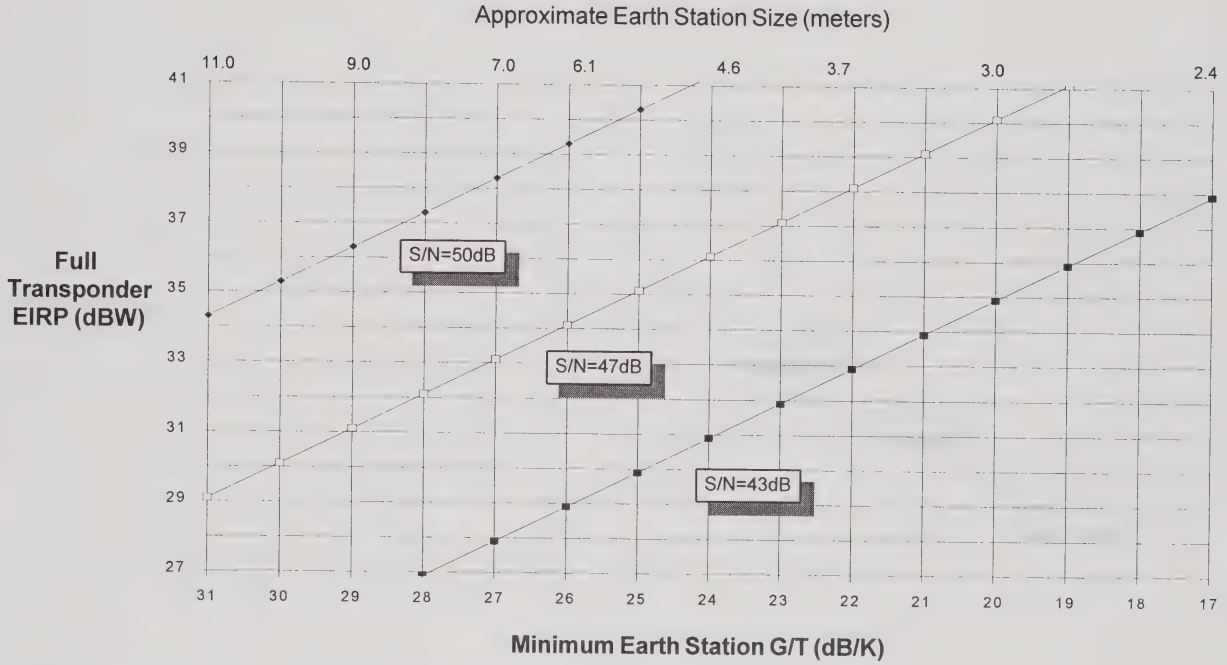
C-Band Single Channel (30 MHz) NTSC Video
Minimum Earth Station G/T vs Satellite EIRP



Notes: 1) Transponder operated with a single carrier at saturation.
2) All values are clear sky. Attenuator Setting is 7.0 dB.
3) A 1.0 dB system margin included in all calculations.
4) Earth Station G/T is controlling factor.

PanAmSat

C-Band Dual Channel (27 MHz) NTSC Video
Minimum Earth Station G/T vs Satellite EIRP



Notes: 1) Transponder operated at 1.6 dB total output backoff, 4.6 dB per carrier.
2) All values are clear sky. Attenuator setting is 7.0 dB.
3) A 1.0 dB system margin included in all calculations.
4) Earth Station G/T is controlling factor.

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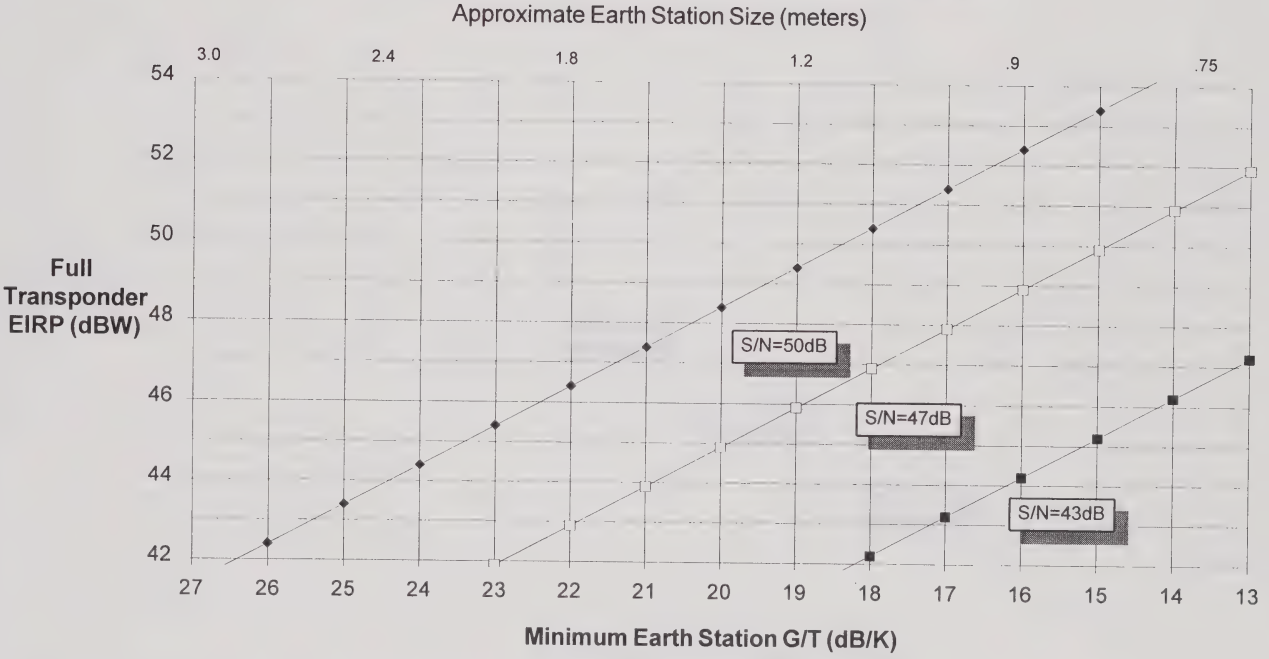
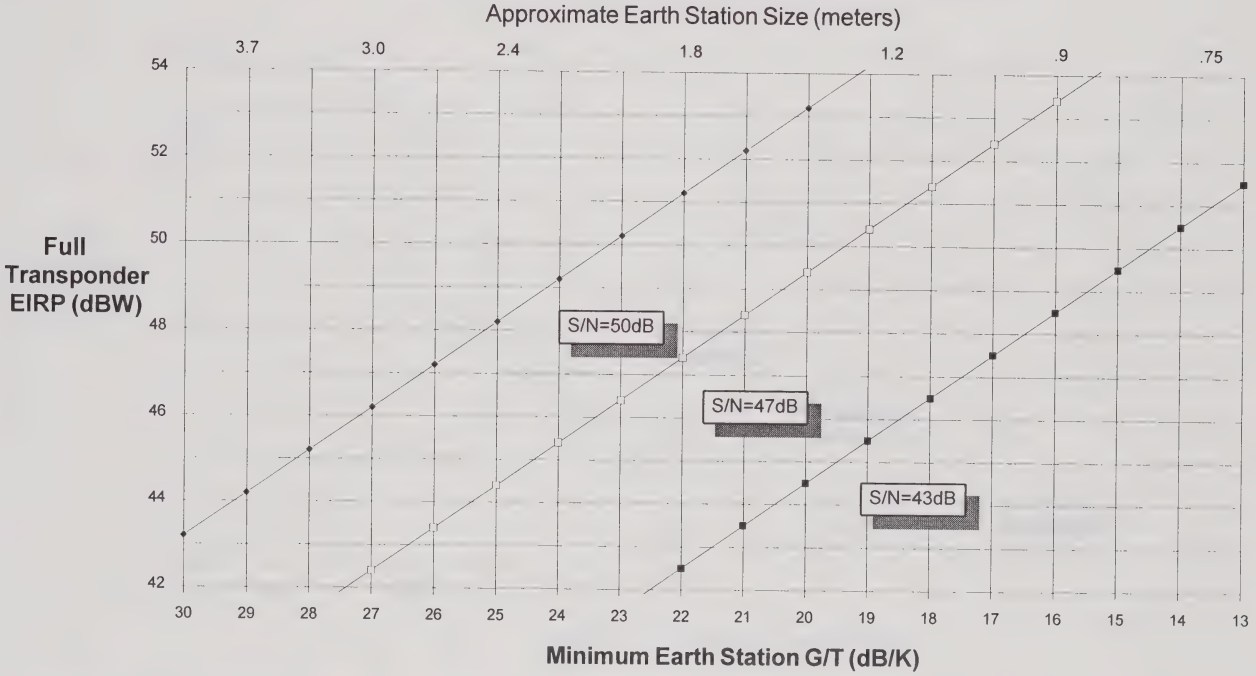
Ku-Band Single Channel (30 MHz) NTSC Video
Minimum Earth Station G/T vs Satellite EIRP



Notes: 1) Transponder operated with a single carrier at saturation.
2) All values are clear sky. Attenuator Setting is 11.0 dB.
3) A 1.0 dB system margin included in all calculations.
4) Earth Station G/T is controlling factor

PanAmSat

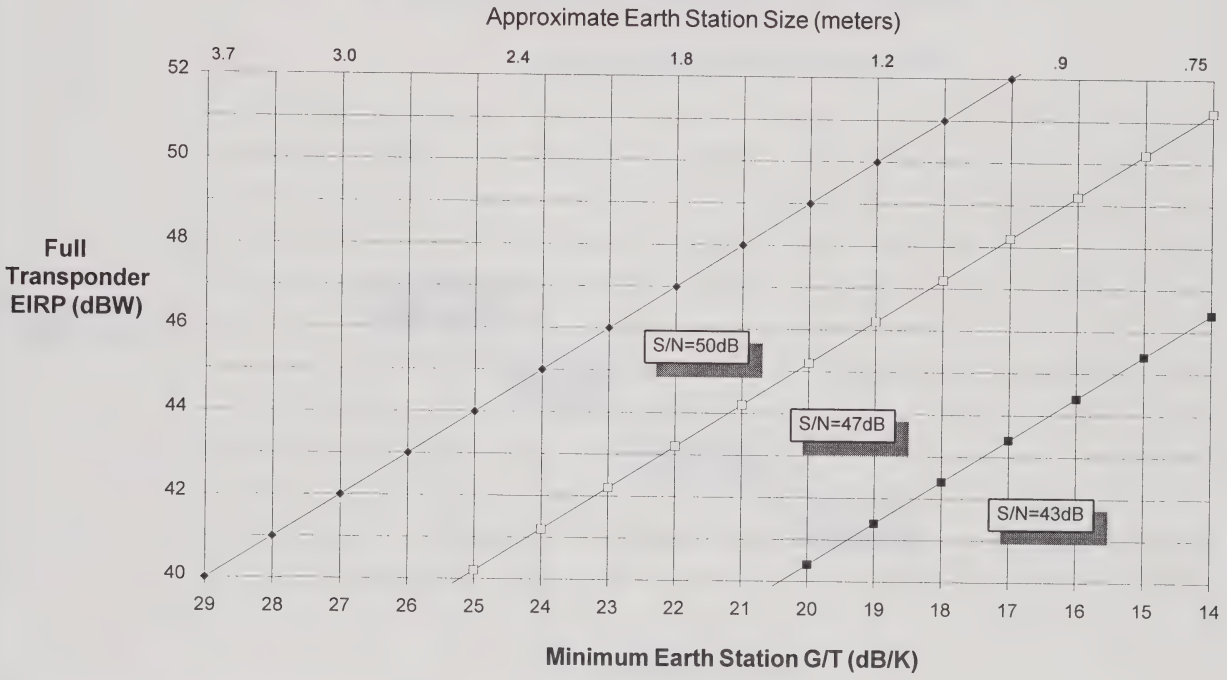
Ku-Band Dual Channel (27 MHz) NTSC Video
Minimum Earth Station G/T vs Satellite EIRP



Notes: 1) Transponder operated at 1.2 dB total output backoff, 4.2 dB per carrier.
2) All values are clear sky. Attenuator setting is 11.0 dB.
3) A 1.0 dB system margin included in all calculations.
4) Earth Station G/T is controlling factor.

PanAmSat

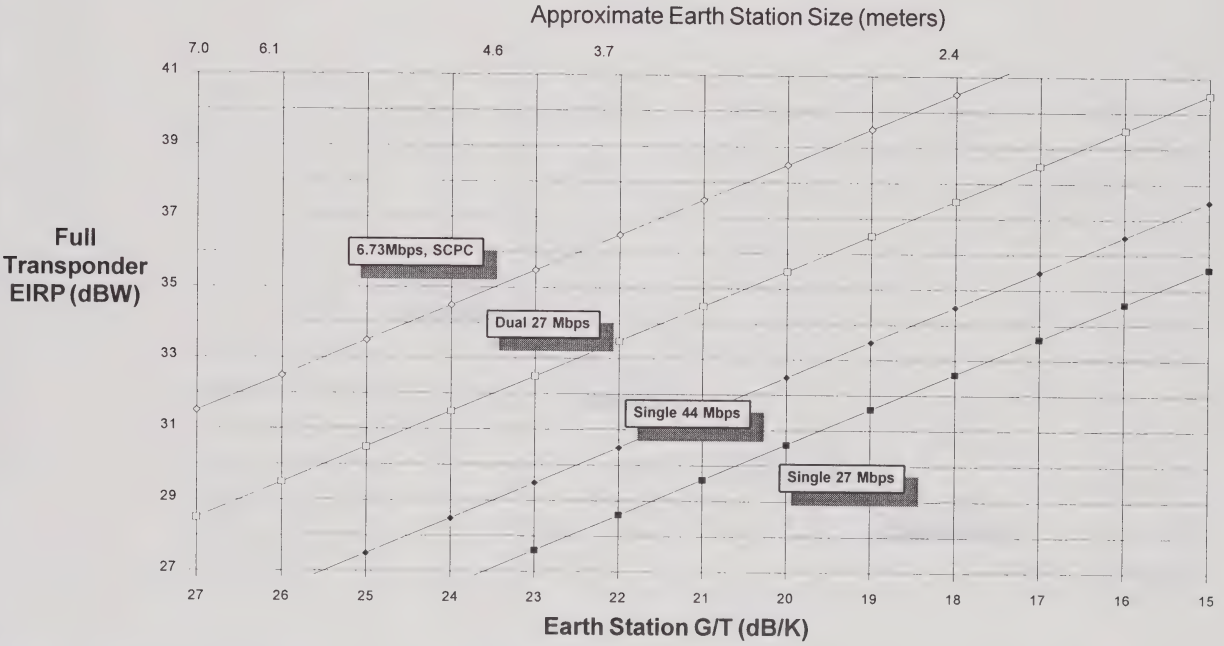
PAS-4 Ku-Band 27 MHz Transponders (27 MHz) NTSC Video
Minimum Earth Station G/T vs Satellite EIRP



Notes: 1) Transponder operated with a single carrier at saturation.
2) All values are clear sky. Attenuator Setting is 11.0 dB.
3) A 1.0 dB system margin included in all calculations.
4) Earth Station G/T is controlling factor

PanAmSat

Minimum Downlink Earth Station Requirements for C-Band Compressed Digital Video Carriers



Notes: 1) QPSK R3/4 C/N=7.0 dB. A 1.0 dB system margin included in all calculations. Attenuator Setting=7 dB.
2) Clear Sky Conditions, IBO=0 dB, OBO=0 dB for single, OBO=1.6 dB for dual MCPC, IBO=3.8 dB, OBO=3.5 dB for SCPC.
3) Earth Station G/T is controlling factor.

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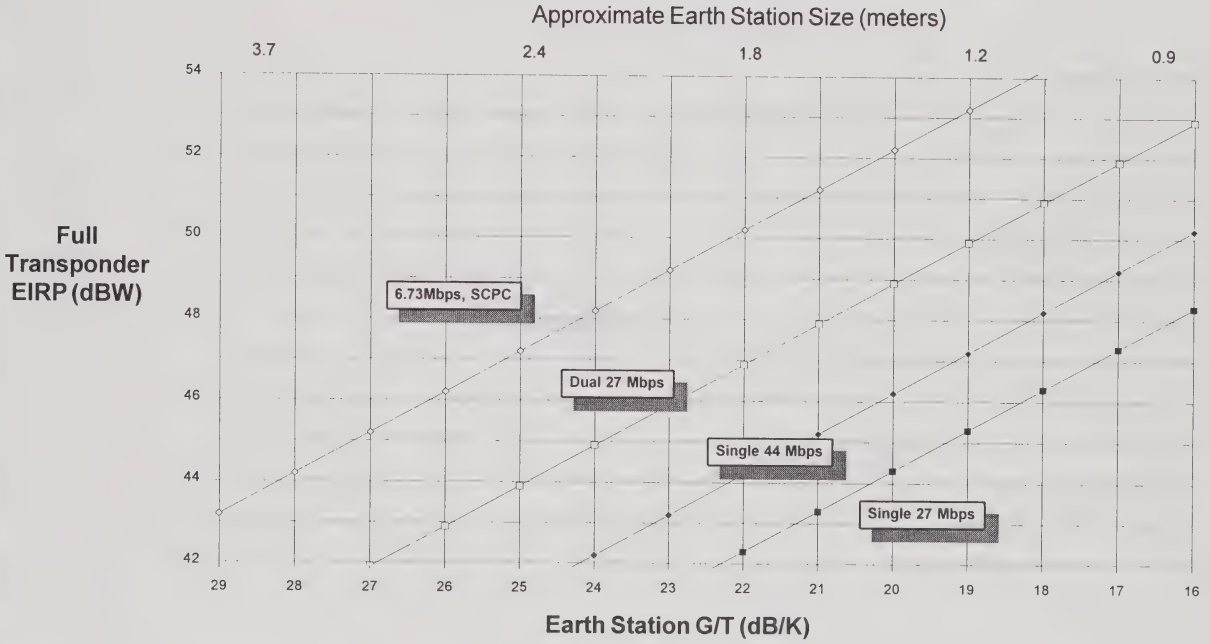
Minimum Downlink Earth Station Requirements for Ku-Band Compressed Digital Video Carriers



Notes: 1) QPSK R3/4 C/N=7.0 dB. Attenuator Setting=11 dB.
2) Degraded Conditions, IBO=0 dB, OBO=0 dB for single, OBO=1.2 dB for dual MCPC, IBO=8.2 dB, OBO=3.5 dB for SCPC.
3) A minimum 2.5/3.5 dB uplink/downlink rain margin and a 1.0 dB system margin included in all calculations.
4) Earth Station G/T is controlling factor.

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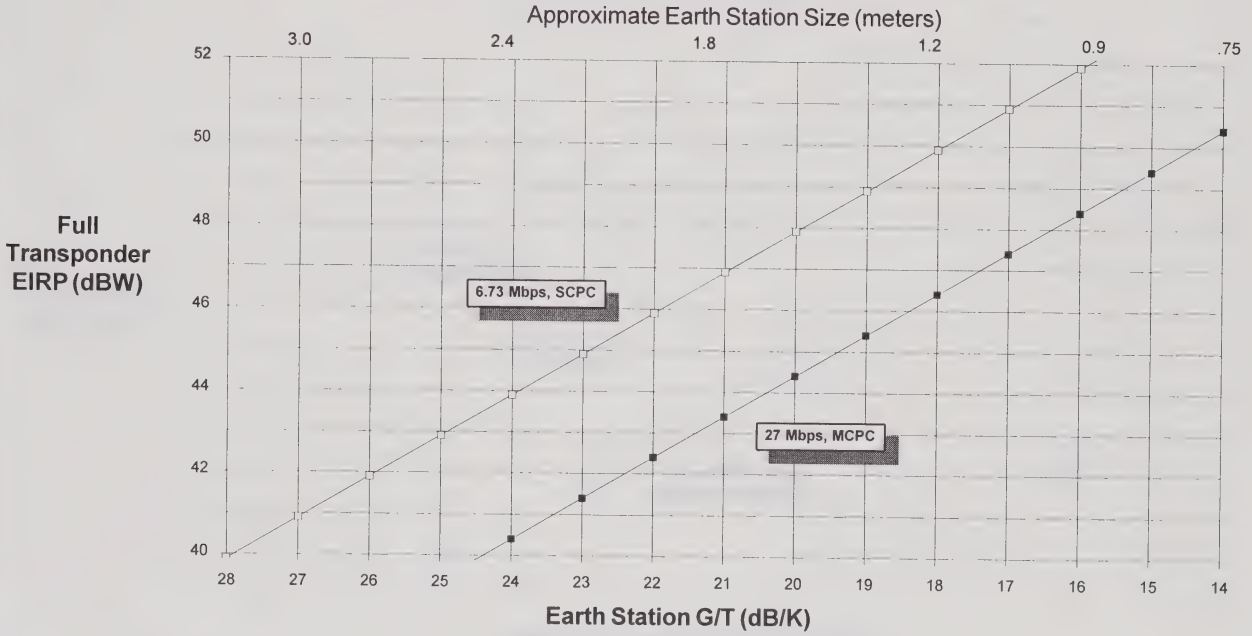
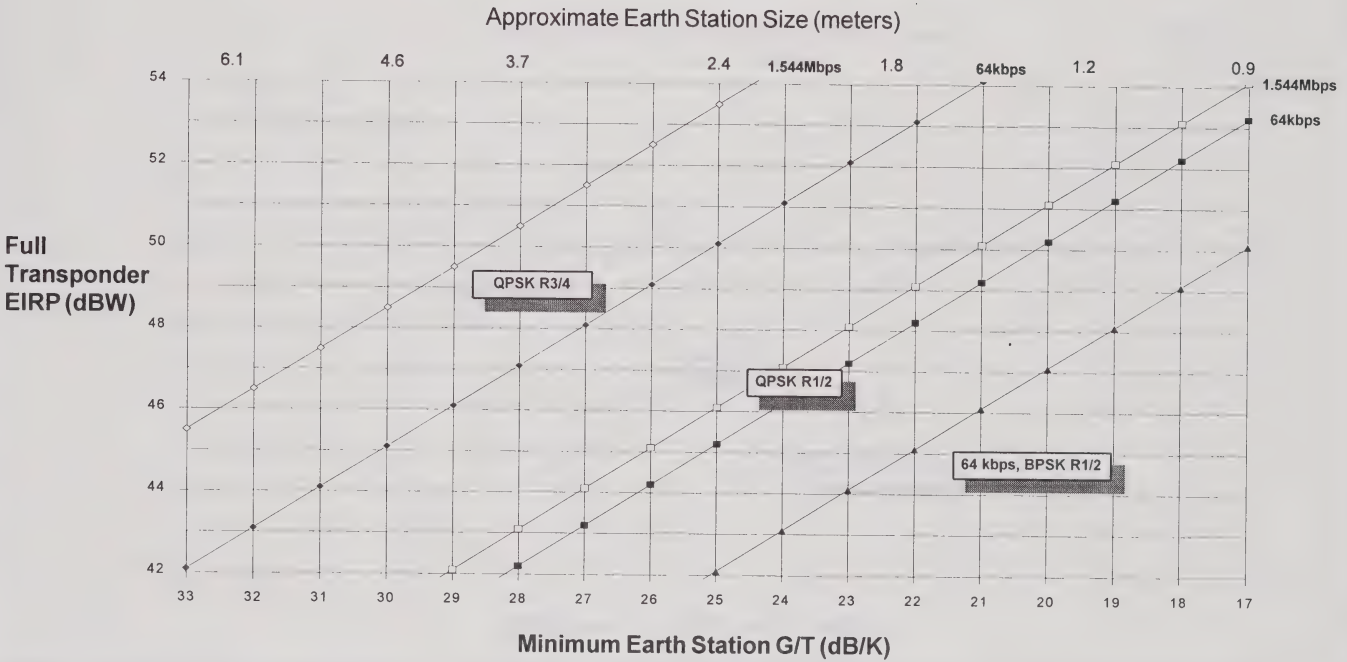
PAS-4 Ku-Band 27 MHz Transponders
Minimum Downlink Earth Station Requirements for
Ku-Band Compressed Digital Video Carriers



Notes: 1) QPSK R3/4 C/N=7.0 dB. Attenuator Setting=11 dB.
2) Degraded Conditions, IBO=0 dB, OBO=0 dB for MCPC, IBO=8.2 dB, OBO=3.5 dB for SCPC.
3) A minimum 2.5/3.5 dB uplink/downlink rain margin and a 1.0 dB system margin included in all calculations.
4) Earth Station G/T is controlling factor.

PanAmSat

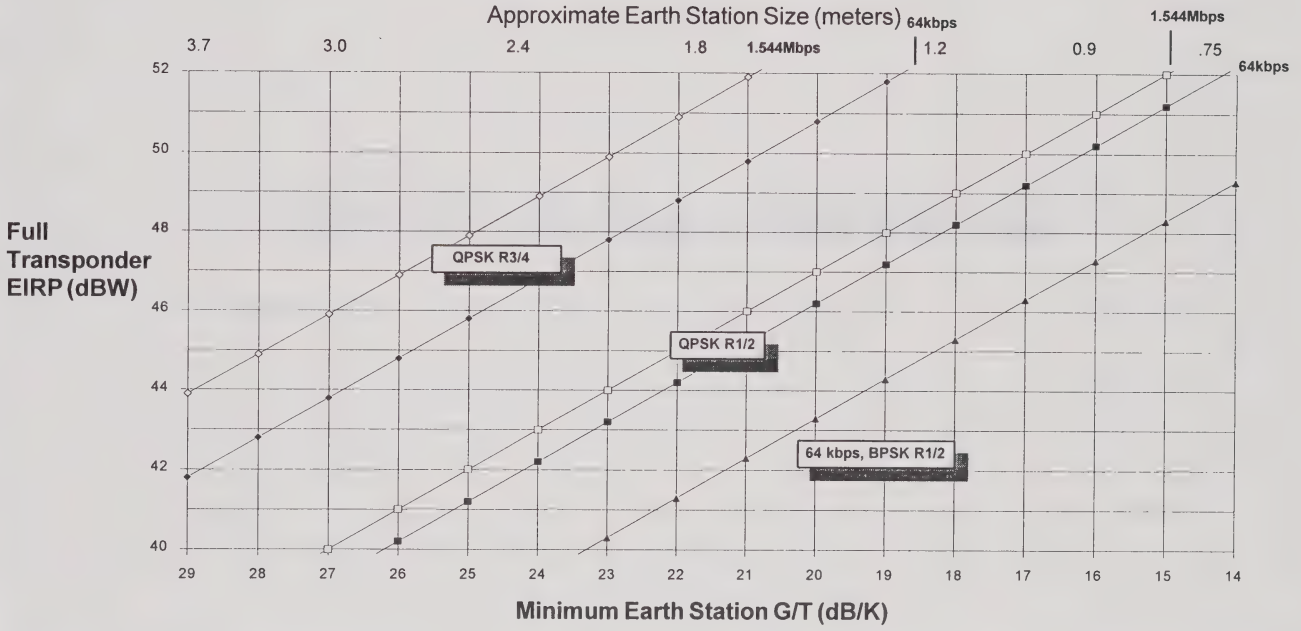
Minimum Downlink Earth Station Requirements for Bandwidth Limited Operations
Ku-Band Data Carriers (64 Kbps to 1.544 Mbps)



Notes: 1) QPSK R1/2 C/N= 5.3 dB (64 kbps), 5.7 dB (1.544 Mbps), QPSK R3/4 C/N=8.0 dB (64 kbps), 8.5 dB (1.544 Mbps), BPSK R1/2 C/N=2.9 dB.
2) Degraded Conditions, IBO=8.2 dB, OBO=3.5 dB, Attenuator Setting=11.0 dB, 64 MHz Transponder.
3) A minimum 2.5/3.5 dB uplink/downlink rain margin and a 1.0 dB system margin included in all calculations.
4) Earth Station G/T is controlling factor.

PanAmSat

PAS-4 Ku-Band 27 MHz Transponders
Downlink Earth Station Requirements for Bandwidth Limited Operations
Data Carriers (64 Kbps to 1.544 Mbps)



Notes: 1) QPSK R1/2 C/N= 5.3 dB (64 kbps), 5.7 dB (1.544 Mbps), QPSK R3/4 C/N=8.0 dB (64 kbps), 8.5 dB (1.544 Mbps), BPSK R1/2 C/N=2.9 dB.
2) Degraded Conditions, IBO=8.2 dB, OBO=3.5 dB, Attenuator Setting=11.0 dB.
3) A minimum 2.5/3.5 dB uplink/downlink rain margin and a 1.0 dB system margin included in all calculations.
4) Earth Station G/T is controlling factor.

Uplink Earth Station Sizing Guides

Uplink Earth Station Sizing Guides

Notes on Use

1) All links based on clear sky and should be used for comparison purposes only. Specific links should be individually calculated.

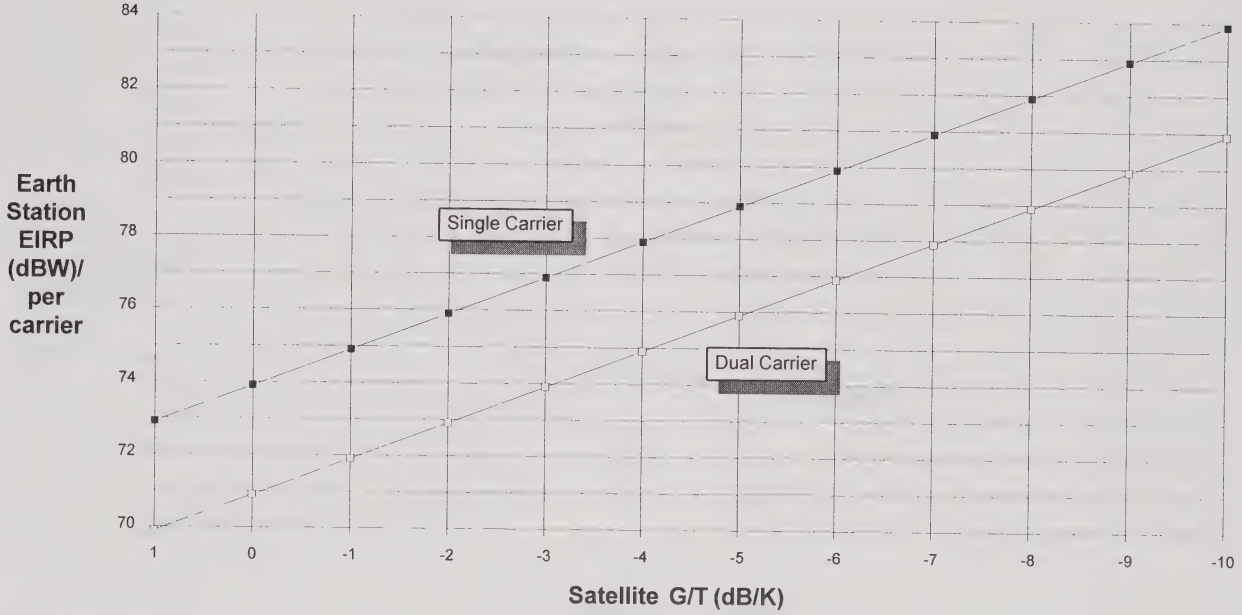
2) No earth station backoffs have been included.

3) Uplink noise contribution is assumed to be negligible due to EIRP levels and attenuator settings. All uplink path loss is based on an elevation angle of 20^{o}.

4) Earth station transmit EIRP is controlling value.

PanAmSat

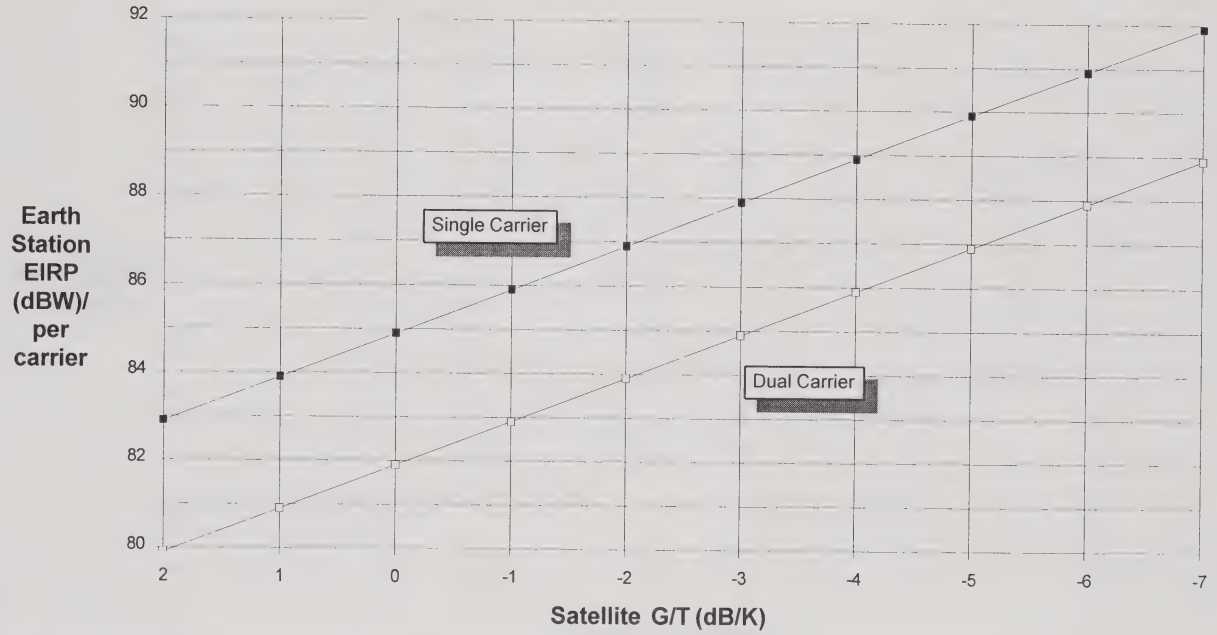
C-Band Uplink EIRP (Analog or Digital) vs Satellite G/T



Notes: 1) Nominal beam center SFD is -96 dBW/m^2 when attenuator setting is 0 dB and G/T is 0 dB.
2) Uplink attenuators range from 0-15 dB. Charts reflect 7 dB setting.
3) Dual carrier output backoff is assumed to be 4.6 dB per carrier.
4) A 1.0 dB system margin is included.
5) Specific links should be confirmed with link budgets.

PanAmSat

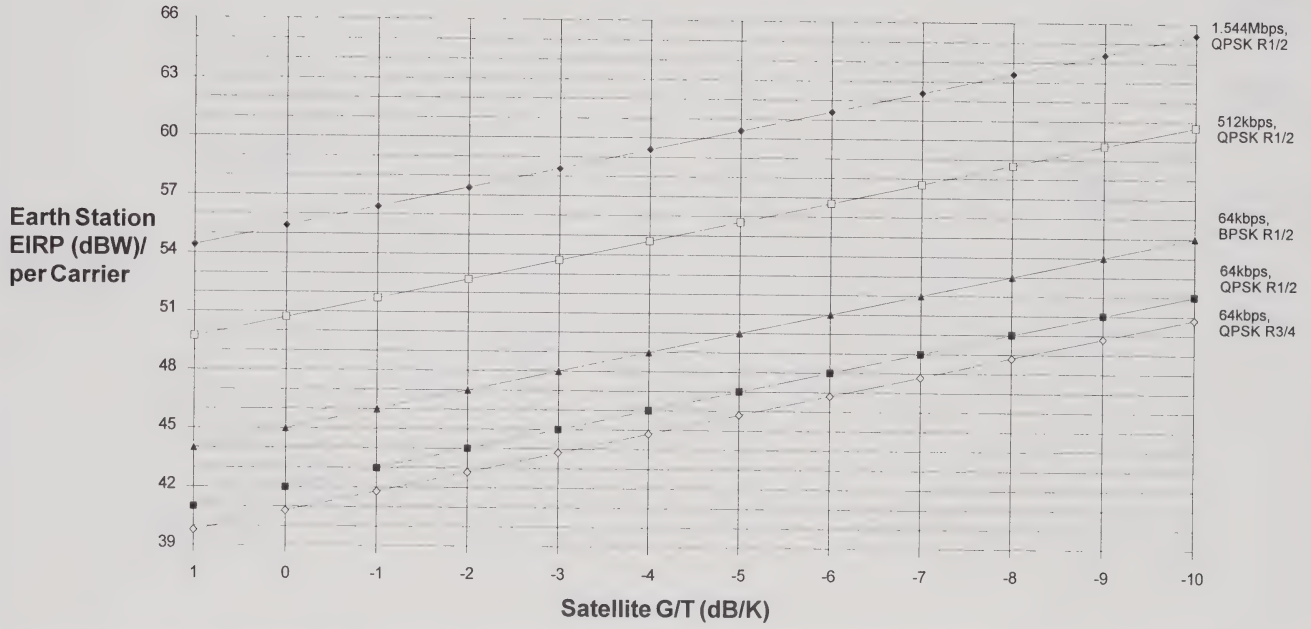
Ku-Band Uplink EIRP (Analog or Digital) vs Satellite G/T



Notes: 1) Nominal beam center SFD is -89 dBW/m^2 when attenuator setting is 0 dB and G/T is 0 dB.
2) Uplink attenuators range from 0-15 dB. Charts reflect 11 dB setting.
3) Dual carrier output backoff is assumed to be 4.2 dB per carrier.
4) A 1.0 dB system margin included.
5) Specific uplink configurations must be confirmed with link budgets.

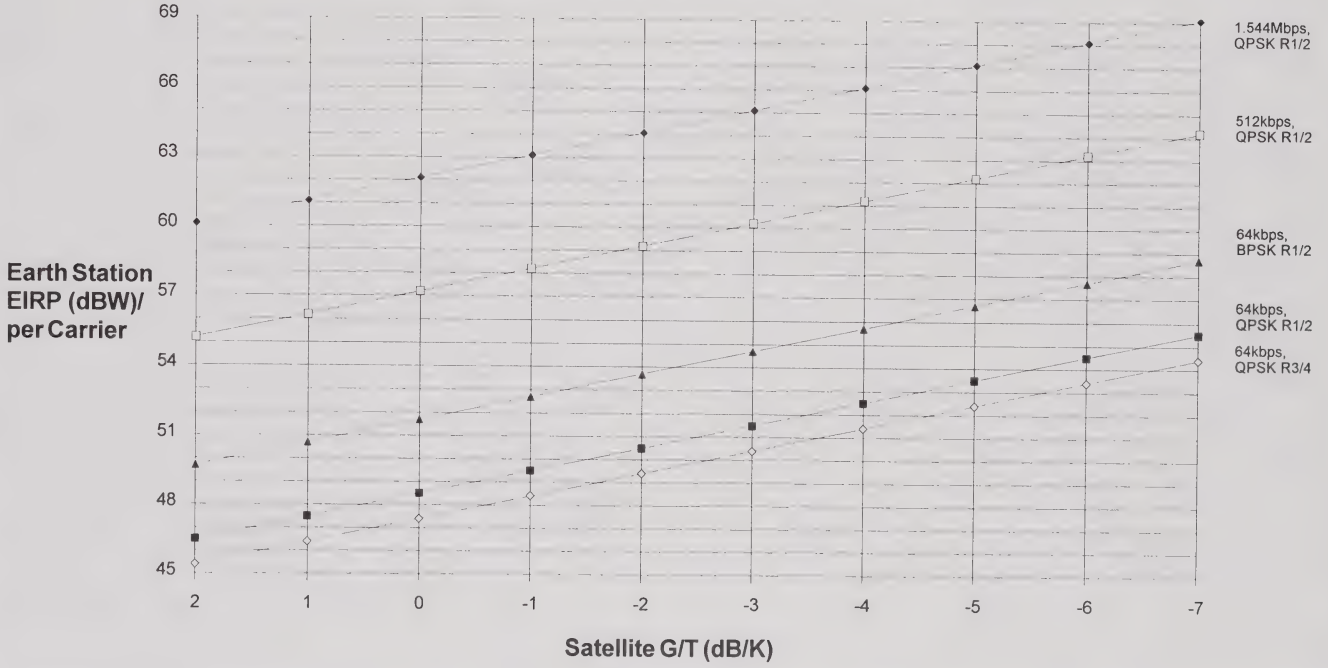
PanAmSat

Typical Earth Station EIRP Assuming Bandwidth Limited Operation
C-Band Data Carriers (64 Kbps to 1.544 Mbps)



Notes: 1) QPSK R1/2 C/N=6.2 dB (64 kbps), 6.8 dB (512 kbps & 1.544 Mbps), BPSK R1/2 C/N=3.4 dB, QPSK R3/4 C/N=8.8 dB.
2) Clear Sky Conditions, IBO=3.8 dB, OBO=3.5 dB, Attenuator Setting=7 dB, 64 MHz Transponder.
3) A 1.0 dB system margin included in all calculations.

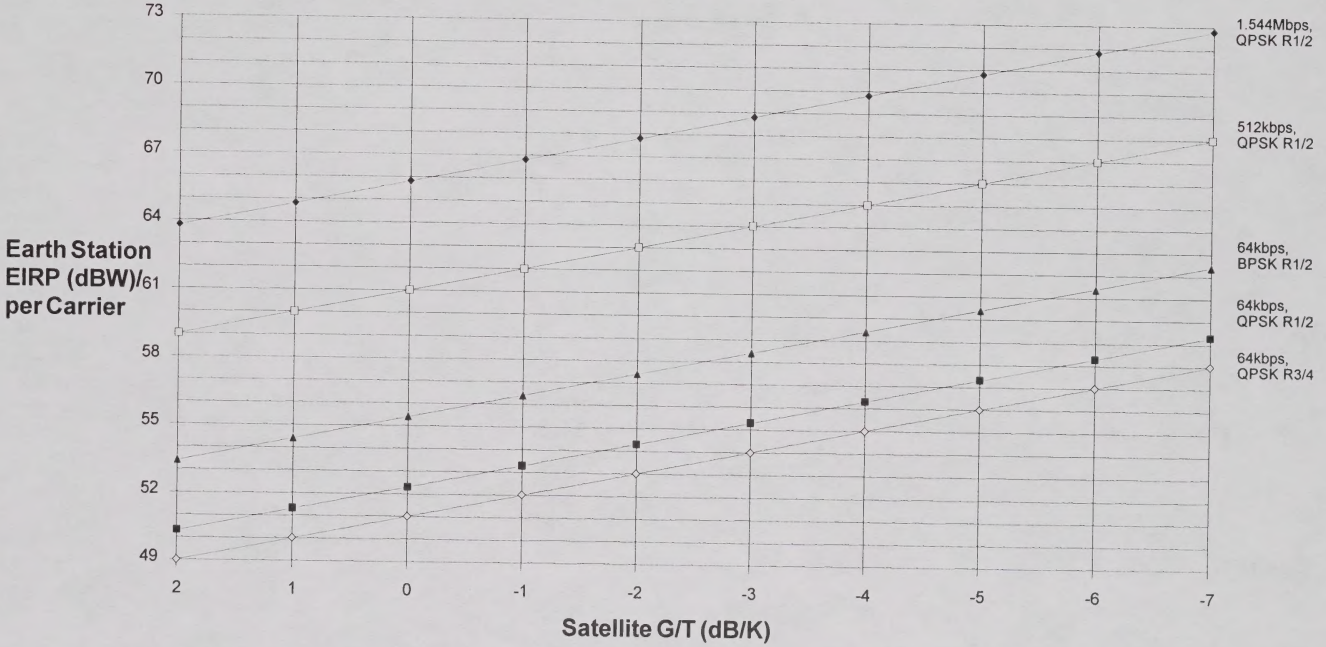
Typical Earth Station EIRP Assuming Bandwidth Limited Operation
Ku-Band Data Carriers (64 kbps to 1.544 Mbps)



Notes: 1) QPSK R1/2 C/N=6.2 dB (64 kbps), 6.8 dB (512 kbps & 1.544 Mbps), BPSK R1/2 C/N=3.4 dB, QPSK R3/4 C/N=8.8 dB
2) Operating Conditions, IBO=8.2 dB, OBO=3.5 dB, Attenuator Setting=11 dB, 64 MHz Transponder.
3) A 1.0 dB system margin included in all calculations.

PanAmSat

PAS-4 27 MHz Transponders
Typical Earth Station EIRP Assuming Bandwidth Limited Operation
Ku-Band Data Carriers (64 kbps to 1.544 Mbps)



Notes: 1) QPSK R1/2 C/N=6.2 dB (64 kbps), 6.8 dB (512 kbps & 1.544 Mbps), BPSK R1/2 C/N=3.4 dB, QPSK R3/4 C/N=8.8 dB
2) Operating Conditions, IBO=8.2 dB, OBO=3.5 dB, Attenuator Setting=11 dB.
3) A 1.0 dB system margin included in all calculations.